PRINCIPLES AND PRACTICE OF OBSTETRIC ANAESTHESIA

Principles and Practice of

OBSTETRIC ANAESTHESIA

By

J SELWYN CRAWFORD

M.B Ch.B, D A (ENGLAND) F F A R.C.S

Anaesthesia Service

The Presbyterian Hospital New York

Late Senior Registrar and First Assistant Department of Anaesthesia

Central Middlesex Hospital London

BLACKWELL

SCIENTIFIC PUBLICATIONS

OXFORD

Published simultaneously in the United States of America by Charles C Thomas Publisher 301 327 *East Lawrence Avenue Springfield Illinois*

Published simultaneously in Canada by The Ryerson Press Queen Street West Toronto 2

First printed 1959

PRINTED IN GREAT BRITAIN FOR BLACKWELL SCIENTIFIC PUBLICATIONS LTD
BY BILLING AND SONS LIMITED GUILDFORD AND LONDON
AND BOUND AT THE KEMP HALL BINDERY

To my Mother and Father
with Gratitude
for their Understanding and Sacrifice

CONTENTS

INTRODUCTION

The adding of a new title to the catalogue of medical works is a responsibility which may be justifiably undertaken on one of only two counts if the aim is to fill a gap in the literature or if the author feels capable of presenting in a more palatable manner facts and ideas which have already reached the library shelves In the present case the plea is based on the former indication

At the time of writing no British textbook of obstetric anaesthesia remains in print. Although the subject is dealt with in textbooks of both obstetrics and anaesthetics discussion necessarily tends to be somewhat cursory It is axiomatic that sound practice stems from knowledge wedded to experience and an attempt has been made here to gather together the facts and many of the theories which must be understood by an anaesthetist before he can intelligently apply himself to the management of an obstetric patient. The days of empiricism in anaesthesia for general surgery are fast passing for obstetric anaesthesia they still flourish. The pages which follow reveal that we remain ignorant of many aspects of the subject, notably regarding the problems of placental transmission and of neonatal respiration However there is much known which is immediately applicable to sound obstetric anaesthetic procedure and it is surely time that the principles were put into more general use

Repeatedly throughout this decade the pages of the *Lancet* and the *British Medical Journal* have revealed that there is considerable disquiet regarding our standards of anaesthesia for obstetrics The criticisms may be resolved into two categories the one concerned with method and the other with service The primary aim of this book is to present an evaluation of the range of methods of anaesthesia and analgesia with reference to physiological and pharmacological processes Some mention must also be made however of the deficiencies in our anaesthesia service

Despite the fact that we have a large and still growing population of anaesthetists whose work is confined almost entirely to hospital practice in recent years obstetric needs have been met by an increase in neither quantity nor quality of attention Obstetric anaesthesia remains the

Anaesthetists must also bear considerable responsibility for the current failure to reduce the perinatal mortality and morbidity rates but the analysis of the factors concerned is difficult

The United States has similar problems In 1955 the maternal mortality was 0 47 per 1 000 live births with a total of about four million deliveries [5] Referring to a somewhat earlier period (1944-53), Matson and Jacoby[6] have indicated that surveys reveal 3-10 per cent of the deaths to be the result of anaesthesia In response to this situation leading American anaesthetists notably Hingson[5] and Apgar[7] have urged a 24-hour anaesthetic service for obstetrics combined with a closer collaboration between anaesthetists obstetricians and paediatricians in both routine work and in the investigation of the problems involved. That such proposals can be advanced for immediate adoption in a country which still suffers from a serious shortage of anaesthetists delineates even more sharply the poverty of our own efforts

Obstetric anaesthesia and analgesia cannot be satisfactorily undertaken merely by transposing to the labour ward the methods learned in the general operating theatre Further specialized knowledge and techniques are needed.

The welfare of the child, also is a direct responsibility of the obstetric anaesthetist. By virtue of his special training the anaesthetist has a unique contribution to make towards the problems of ensuring an adequate oxygen supply for the foetus of avoiding centrally-induced neonatal depression of resuscitating the newborn and of preventing or treating regressing pulmonary efficiency in the newborn As in the case of maternal morbidity these problems become of increasing concern as the previous major causes of perinatal death are reduced in importance On a national scale anaesthetists are not yet facing their responsibilities in this field. The problems in terms of both research and of day-to-day application can be attacked satisfactorily only by the concerted action of obstetricians paediatricians and anaesthetists (physiologists and other laboratory workers have of course a great part to play in the special centres) each of whom is willing to work under the direction of the others depending upon the shifting requirements of the situation

This is no place in which to discuss the larger questions involved in an expansion of the anaesthetic service fully to meet these requirements It might be suggested, however that the urgent demands of obstetrics are likely to be met to a greater extent by a reorganization than by a reinforcement of each anaesthetic department

The common function of an Introduction is to survey the environment —both historical and contemporary—of the subject to be dissected in the

Cinderella of the speciality in most hospitals—including those of considerable repute—and all too frequently anaesthesia for forceps delivery is left in the hands of the junior resident unsupervised, and with only the smatterings of experience in the general theatre That most obstetric operations are emergencies occurring at awkward hours is the basic cause of this administrative failure but it is also the very reason why increased skill and attention are called for in these cases

The national maternal and infant mortality rates have been falling in a gratifying manner during the past twenty years These declines have resulted from improvement in many lines of therapy notably in the combating of sepsis and of shock, but not from improvement in standards of anaesthesia The latter is now by contrast becoming a prominent cause of maternal mortality and must thus be indicted as a major factor in infant mortality and morbidity In 1955 there were 667 811 live births 439 maternal deaths and a maternal mortality rate of 0 66 per 1 000 in England and Wales [1] Of the maternal deaths 251 were associated with complications of pregnancy (excluding urinary tract infection and ectopic pregnancy) or with delivery (Brews p 713) One hundred and twenty of these were associated with actual delivery and failure of complete anaesthetic management must have played a significant part in many of these tragedies The Report just quoted indicated that in the three-year period 1952–54 in England and Wales 49 maternal deaths were directly attributable to complications of anaesthesia and in another 20 cases anaesthesia was a contributing factor To this total of 69 must be added an unspecified number in which the anaesthetist was at fault in his role as resuscitator Comparable figures will certainly apply to the whole of the United Kingdom

Dinnick[3] has shown that in England and Wales in 1954 general anaesthesia was administered for 67 600 of the 432 000 deliveries occurring in hospitals and regional methods were used in a further 19 000 cases When considered in relation to the round total of two million anaesthetics (excluding dental gases)[4] administered annually in the United Kingdom these figures speak for themselves If we relegate to a position of neglect one patient out of every twenty-five requiring anaesthesia we are failing in our professional duty This is the very least of the matter for no mention has been made of the 900 000 deliveries occurring each year in the United Kingdom during the course of which techniques and drugs of direct concern to the anaesthetist are regularly used. The negligence of British anaesthetists in this regard ill-becomes the country in which was first demonstrated a rationally controlled method for the relief of pain in childbirth

Bert B Hershenson Robert A Hingson, Clement A Smith Virginia Apgar, E H Seward, Hilda Roberts Ian Donald and R Bryce-Smith. It is largely due to the initiative of these men and women that ease of pain in childbirth has been and continues to be rendered more efficient and more safe for both mother and child

Finally my thanks go to Miss Marjorie Kuck M R C O G in Toronto and to Dr R E Molloy F F A R C S now returned to London from Pittsburgh for reading the draft text with the aim of discovering any gross errors of fact in obstetric and anaesthetic matters They are not to be held responsible for any of the opinions assessments or recommendations expressed.

J S C

September 1958

REFERENCES

1 Report on Confidential Enquiries into Maternal Deaths in England and Wales 1952-54 Ministry of Health Reports on Public Health and Medical Subjects No 97 H M S O London 1957
2 Brews A (1957) *Eden and Holland s Manual of Obstetrics* 11th ed London Churchill
3 Dinnick O P (1957) Discussion on general anaesthesia for obstetrics *Proc roy Soc Med* 50 547
4 Compiled from various unofficial sources no authoritative figures are to hand
5 Cull W A and Hingson R A (1957) Dedication education and organization in the round the-clock staffing of a modern obstetrical analgesia and anesthesia service *Bull Mat Welfare* Sept -Oct
6 Matson J E and Jacoby J (1957) Maternal mortality and morbidity from anesthesia *J int Coll Surg* 28 172
7 Apgar V (1955) Role of the anesthesiologist in reducing neonatal mortality *N Y St J Med* 55 -365
8 Hershenson B B (1955) *Obstetrical Anesthesia Its Principles and Practice* 1st ed p 176 Springfield Ill Thomas
9 Burge E S and Baldwin C E (1956) Use of spinal anesthesia in obstetrics at the Evanston Hospital *Amer J Obstet Gynec* 71 973

body of the book In this respect it is felt that two further matters must be presented one a warning and the other a tribute

Most hospital practitioners regularly consult the leading journals concerned with their speciality and published in other lands In the English-speaking communities reading is probably confined to the journals from the Commonwealth the United States and Scandinavia Interpretation of the views expressed and of the results reported in these articles must to some extent be based upon an appreciation of the medico-social background of the community under investigation In the field with which this book is concerned the point assumes great importance when attention is directed to the literature of the United States and Canada Readers on the eastern shores of the Atlantic would do well to bear in mind the following facts

The midwife system is virtually non-existent in North America almost all deliveries being conducted by the attending physician or obstetrician (in the U S A 85 per cent of the total occur in hospitals) Outside of the renowned institutions this not infrequently leads to a call to delay the progress of delivery in order that the accoucheur may reach his patient in time[8, 9] The vast majority of deliveries are instrumental the practice being founded upon well-engrained views on saving the perineum and avoiding prolonged pressure on the foetal head. Consequently the very large numbers of forceps deliveries often quoted are in effect biased by the inclusion of many cases of normal women undergoing normal pregnancies and having normal infants In North America active participation by the mother in her labour is not generally observed and there is a vociferous demand for the obliteration of all awareness of the birth process for sedation and for if possible amnesia Hingson s introduction of the regime of continuous caudal analgesia has to some extent offset the latter two requirements

It is important that these factors be borne in mind whenever articles from Canada or the U S A are consulted just as it is necessary for North American readers to appreciate the working conditions in Britain and Scandinavia when assessing the results published in these countries

As was said earlier this book was conceived mainly because there appeared to be a need to collect and to analyse the plethora of pronouncements and observations on the subjects of obstetric analgesia and anaesthesia and of neonatal resuscitation Inevitably therefore it is founded upon the work of many people who have been prominent in this field during the past century A very personal call is felt to pay tribute to the following inspiring workers Sir James Young Simpson John Snow Carl Gauss Sir James Barcroft R J Minnitt Stewart H Clifford

the gain is notably accelerated during the course of the third trimester reversal of the process being initiated only after delivery The intravascular water retention increases only slightly during the first trimester the gradient steepens thereafter until just before the onset of labour when there is a sharp and significant fall

Salt retention closely accompanies water retention throughout pregnancy Both processes are probably related to the secretion of steroids by the placenta. In the post-partum period following a normal pregnancy on the average about 5 gm sodium is 'shed by the mother

The other components of the blood also follow a pattern of volumetric change during pregnancy Total blood volume decreases during the first two months and thereafter rises gradually until the time of delivery Plasma volume increases steadily throughout pregnancy until just before the onset of labour when there is a significant fall Red cell volume after an initial fall during the first two months rises with the progress of pregnancy until the time of delivery However the increasing hypervolaemia outstrips the rise in red cell volume and haemoglobin mass leading to haemodilution and an apparent anaemia as term approaches A red cell count of 3·75 million per c cm. a haemoglobin of 11-12 gm per cent, and a haematocrit of 35 per cent have been suggested as the lower levels of normal at term Because of foetal demands made upon the maternal iron supplies there is always a tendency for a true anaemia to develop It is almost always necessary to supplement a normal good diet with iron throughout pregnancy in order to build a store with which the heavy demands of the final trimester may be met. It is the duty of the anaesthetist in co-operation with the obstetrician to watch for anaemia and to treat it should it occur in a patient under his care. It is generally accepted that the maternal blood loss during a normal delivery might reach 500-600 ml

The platelets which remain fairly constant in concentration during pregnancy increase abruptly in number during the late stages of labour There is in addition a total increase and a relative increase in the fibrinogen content of the plasma, the total amount being 40 per cent greater than normal—despite a diminution of plasma protein concentration there is actually a gain of about 18 per cent in the total circulating mass near term Although these two factors are important in curbing haemorrhage they might also lead to an increased liability to thrombo-embolic phenomena during the puerperium and should spur the anaesthetist to increased care in the matters of foot-stirrups leg-rests and general positioning of the patient

CHAPTER I

THE MOTHER

EVERY anaesthetist is a doctor It is to be expected therefore that obstetric anaesthetics will be administered always by practitioners having some knowledge of the significant changes accompanying pregnancy Furthermore the anaesthetist will be aware of the general mechanics and physiology of labour and of how these might vary It is only by weaving his specialized skill into the framework of this basic knowledge that he is able to offer maximum aid to both the patient and the obstetrician

As in all medicine co-operation is the key-word. The anaesthetist must be able to anticipate the difficulties which the obstetrician might encounter during delivery and must be prepared to allow him the best operating conditions compatible with the safety of his two patients Reciprocity is of course implicit in co-operation A good obstetrician appreciates the limitations of anaesthesia and the dangers which it presents to mother and child In addition in any good team each doctor will know the individual adequacies of the other and will modify his technique accordingly

In the years of his training and—in the case of the occasional obstetric anaesthetist—during the long summer of his consultancy recollections of his undergraduate tuition in obstetrics will fade in the mind of the anaesthetist This chapter is an attempt to present a *resumé* of the important anatomical and physiological considerations of pregnancy and labour relative to the practice of anaesthesia In emphasis and approach it is a considerable distortion of the obstetric viewpoint this is natural enough as obstetrician and anaesthetist contemplate the patient from opposite poles

Normal Pregnancy and Labour

1 VARIATIONS IN BLOOD AND BODY FLUID

Water retention is a normal concomitant of pregnancy There is general retention throughout the tissues but the proportions held in the intra- and extra-vascular compartments vary in each trimester The extra-vascular fluid increases gradually during the first six months and

contraction The subject will be further discussed in this and subsequent chapters

Although the general venous pressure remains relatively unchanged, the increasing size of the gravid uterus leads to a gradual rise in the femoral venous pressure continuing through the second and third trimesters At term the pressure reaches about 18 mm Hg compared with the normal 6 mm Hg *It should be noted that when the patient is supine* as in operative obstetrics the inferior vena cava—which receives the uterine venous outflow—is directly subject to these pressure changes

3 ALTERATIONS IN THE MECHANICS OF RESPIRATION

Despite the encroachment of the diaphragm into the thoracic cavity pulmonary ventilation is actually increased during pregnancy This increase is initiated in the first trimester and continues gradually throughout pregnancy It is a result of a rise in both respiratory rate and tidal volume The rate is increased to the point of dyspnoea in about 60 per cent of women during the final trimester Broadening of the chest and a change from abdominal to thoracic breathing contribute to the physiological compensation for a decreased thoracic height and the tidal volume increases by an average of about 25 per cent during the months from early pregnancy to term Vital capacity and inspiratory reserve remain unchanged, and thus the expiratory reserve is inevitably decreased.

The respiratory mucosa exhibits a generalized hyperaemia due to capillary engorgement This is to be accepted as increasing however slightly the hazard of intubation especially if the nasal route is used It also tends to increase the discomfort of the dyspnoea of late pregnancy—an increase which is emphasized in the presence of even minor upper respiratory infection These points are of some importance in regard to the application of a face-mask as nose-breathing becomes extremely difficult for some women at term

4 BIOCHEMICAL CHANGES

As pregnancy advances both the oxygen and the carbon dioxide dissociation curves of the mother s blood are shifted slightly to the right This means that during late pregnancy in a low oxygen-tension environment oxygen is more readily released and carbon dioxide more readily taken up by the blood than is the case in the non-pregnant state Oxygen consumption is increased, having by term risen to a level about 10 per cent higher than that obtaining prior to pregnancy Carbon dioxide tension

2 CARDIOVASCULAR CHANGES

The dynamics of the circulation undergo important changes during pregnancy The size of the heart increases slightly but only in proportion to the general weight gain Its position changes as might be deduced from the mechanics of a rapidly growing tumour causing upward displacement of the diaphragm Cardiac output is increased considerably during the middle trimester and thereafter gradually falls reaching a rate a little above normal just before term. During the first stage of labour cardiac output rises again increasing markedly when strong uterine contractions occur At no time however is the myocardial reserve of the pregnant woman without heart disease demonstrably depleted.

During pregnancy the resting pulse-rate increases on the average by 12-20 beats per minute Various changes of rhythm in otherwise normal hearts have been observed they invariably disappear following delivery and are probably of no significance

Systolic blood pressure is unchanged by normal pregnancy The diastolic pressure falls slightly during the greater part of the gestation period, with a resultant increase in pulse pressure but it returns to the pre-pregnancy level during the final month

As would be expected, uterine blood flow increased vastly with the progress of pregnancy It has been computed that towards term blood reaches the uterus at the rate of 500 ml per minute [1] Due to the demands of the foetus oxygen consumption is extremely high (see Chapter II) Furthermore there are during labour greatly significant changes in the continuity of uterine blood flow It has been shown that in the course of a normal contraction the pressure within the uterine muscle rises to about 50 mm. Hg As the venous pressure is only about 4 mm Hg there is a temporary interference with the venous return from the uterus and consequently by retrograde resistance with the arterial supply It has been suggested that this period of relative ischaemia during each contraction is compensated for by a local hyperaemia—induced by the accumulated metabolites—whilst the uterine muscle is at rest The changes in uterine blood flow are said to be accompanied by similar variations in placental blood flow leading to a tidal variation in the amount of oxygen available to the foetus The second of these propositions has not yet been satisfactorily demonstrated, and it is interesting to speculate upon the significance of the large blood-filled intervillous spaces in this respect. Possibly in normal labour the intervillous blood acts as a reservoir from which the foetus can draw an adequate amount of oxygen during a

is prolonged, the use of drugs which are excreted unchanged by the kidney must be limited.

7 Mechanics and Pain Labour

Towards the end of a normal pregnancy the uterus is an extra-pelvic structure. The onset of labour may be heralded by the phenomenon of lightening in which the presenting part descends into the pelvis. Prior to this, although the well-known contractions of Braxton-Hicks occur with considerable frequency there is no pain of any significance associated with normal pregnancy.

The nerve-pathways involved in labour are now well-recognized, their final identification being based largely on the results of Cleland's[3] original work. The propulsive efforts of the uterus contributed largely by the longitudinal muscle fibres of the corpus and fundus are initiated by stimuli travelling via sympathetic fibres whose central origins lie above the level of the sixth thoracic segment. The oncoming foetus is accommodated by active dilatation of the lower segment of the uterus that is by the circular fibres of the lower third of the corpus uteri and those of the cervix. The motor pathways by which this is effected are contained in the parasympathetic outflow from S2 3 and 4. In addition to the neural element, there is a hormonal factor of possibly equal importance in the control of myometrial activity. It is understood that a pituitary derivative closely related to pitocin plays an important part in the initiation of uterine contraction.

The sensory nerve supply is best described in conjunction with an account of the course of labour. The initial contractions are felt as a tightening in the lower abdomen and the lower part of the back.[4] Such sensations are not to be construed as evidence of true labour unless each is accompanied by a palpable uterine contraction. The lower abdominal discomfort is reflexly produced by stimuli arising in the body of the uterus. Afferent nerves from the latter pass via various plexuses of intervening fibres to their cell stations in the eleventh and twelfth thoracic ganglia of each sympathetic chain. From these the associated white rami communicantes travel with the appropriate dorsal nerve root to synapse in the eleventh and twelfth thoracic segments of the spinal cord. In accordance with the general findings regarding visceral sensation pain is therefore referred to the areas supplied by the somatic afferent nerves arising from these segments. Under some circumstances the first lumbar segment might also become involved.

The low backache component of early labour is associated with the start of cervical dilatation. Stimuli from the cervix are transmitted via

and carbon dioxide content are both diminished. The carbon dioxide combining power of the blood decreases from the normal of about 52 volumes per cent to approximately 45 volumes per cent. This reduction in alkali reserve is accompanied by a reduction in total buffer base. It does not, however, represent a true acidosis. The serum pH remains constant. The condition is apparently one of compensated carbon dioxide deficit, a deficit resulting from the increased pulmonary ventilation referred to above. These factors are of considerable importance in the understanding of questions concerning neonatal respiration.

In relation to the foregoing it is as well to remember that during normal pregnancy the basal metabolic rate rises gradually and that at term it might be more than 10 per cent above that obtaining in the non-pregnant state. In addition, there is an increased fat absorption and a rise in plasma fats concentration. Ketosis is not a normal accompaniment of pregnancy but these two shifts, together with the fall in alkali reserve, make the pregnant woman increasingly liable to drift into a ketotic state.

Glycosuria, persistent or intermittent, is a not unusual feature of many pregnancies. It is related to a lowered renal threshold, and to a decreased ability on the part of the liver to store glycogen.

Non-protein nitrogen and blood urea levels are significantly reduced during normal pregnancy.

5. DIGESTIVE DISTURBANCE

The only disturbance of digestion which is of interest to the anaesthetist occurs during labour. It has long been held that there is a considerable reduction in the rate of emptying of the stomach during labour. This tenet is based almost entirely on clinical impression, and is said to hold for both fluid and solid stomach-contents. Radiographic investigation[*] has tended to throw some doubt on the correctness of the view as far as fluid contents are concerned, but it would still serve the anaesthetist well not to take chances in this respect.

6. RENAL TRACT

Of some importance to the anaesthetist is the fact that during pregnancy a slight degree of hydroureter and hydronephrosis develop—especially on the right side. This effect tends to be accentuated during labour due to mechanical factors, and can be a prominent cause of pain early in labour. The pain is referred to the tenth and eleventh thoracic segments. If, as in protracted labour, this process of damming back the flow of urine

involve breath-holding for most of the period of each contraction with two important implications firstly no inhalational analgesia can be given during the bearing-down period and consequently a store of the drug must be built up within the patient during the 20 seconds prior to each such episode secondly, for a 30-40 second period during each contraction the mother is deprived of oxygen and at the same time she performs a variation of Valsalva s manoeuvre These factors are of the greatest concern in the conduct of cases of maternal heart disease and of foetal distress

In some mothers due to reasons of anatomy (unpliable fascial sheaths resistance to stretching of scar tissue) or psychology (involuntary contraction of muscle by an apprehensive patient) the pelvic floor which term implies in effect the levator ani and its attendant fascia continues to resist the passage of the presenting part Such an event is liable to cause increased pain in the S2 S3 and S4 segments and, if untreated to result in some soft-tissue perineal injury It is the latter prospect added to the postulated possibility of danger to the infant because of delay in the second stage plus undue pressure on the foetal skull which has led North American doctors to favour the practice of routine episiotomy and forceps delivery

The sense of distension of the vagina and vulva as they are traversed by the foetus is transmitted by somatic afferents leading to the mid-sacral segments

To allow the accoucheur better control of the rate of delivery and thus to help to avoid tearing the perineal skin and subcutaneous tissue the mother is instructed to stop bearing-down when the head is about three-quarters crowned. To help her to do so she is encouraged to breathe deeply and rapidly through her mouth, thus effectively preventing a Valsalva manoeuvre At the same time she is usually given some additional relief in the form of inhalational analgesia

After delivery of the head, there is usually a quiet interval of about a minute before the next contraction initiates delivery of the shoulders To reduce the chances of obtaining a bad tear during delivery of the shoulders the mother is discouraged from bearing-down at this time

Any pain during the third-stage of labour will be associated with a strong uterine contraction (T11 and T12) vaginal discomfort due to the passage of the placenta is fleeting

8 Some Aspects of Pathology

a Pre-eclamptic toxaemia

To the anaesthetist the outstanding aspects of this condition are

the second, third and fourth sacral components of the parasympathetic system Sensation is appreciated as coming from the sites of distribution of the appropriate somatic afferent fibres

As labour progresses contractions assume a greater regularity and increase in strength and frequency Pain is likely to supercede discomfort when the degree of cervical dilatation has reached about two fingers in the primipara and about three fingers in the multipara From this time and until the end of the first stage of labour each contraction is characteristically accompanied by a waxing-peak-waning pattern of pain The waxing and waning components take the form of a dull ache—respectively increasingly and decreasingly severe—felt in the lower abdomen the low back area and the front and inner aspects of the upper thighs in effect over the area of distribution of T11 T12 L1 S2 S3 and S4 At the peak period there is in addition a severe griping pain which is usually referred to the areas supplied by T11 and T12 When the foetal lie is occipito-posterior the most severe pain in the first stage is nearly always felt in the back often under such circumstances backache persists even between contractions

Classically contractions during the latter-half of the first stage of labour occur about every 3-5 minutes and last for about 1 minute Pain or discomfort is felt during approximately the last 40 seconds of each contraction, and thus there is about a 20-second warning period The remembrance of this fact is of great importance in the successful conduction of inhalational analgesia.

At the end of the first stage the mother becomes a much more active participant in her labour In many cases this change from the era of passivity quickens the interest of the patient and in so doing helps to diminish her appreciation of the pain involved. At the same time both the character and the source of pain are somewhat changed Contractions occur more frequently and give only about 5 seconds warning of the start of pain Hence to provide adequate inhalation analgesia reliance must be placed upon the regularity with which the contractions occur [4] Although the pain of uterine propulsion—transmitted via T11 and T12—persists that due to dilatation of the lower segment is of course ended In place of the latter stimuli arise from the pelvic floor area upon which the head descends with some force following full dilatation of the cervix The afferent fibres here concerned likewise have their central connections situated in the second, third, and fourth sacral segments but are somatic rather than parasympathetic Stimulation of the pelvic floor leads reflexly to an increase in the strength of uterine contractions it also provokes the mother into making voluntary bearing-down efforts The latter

tion during or following the third stage with an attendant danger of severe post partum haemorrhage As an additional factor the placental site is about twice the normal size in these cases and not infrequently extends to the lower uterine segment where retraction is relatively inefficient The routine use of ergometrine has helped to decrease the frequency of this occurrence but recourse might have to be made to a pitocin drip

Significant aspects of pathology in cases of placenta praevia, malpresentations disorders of uterine function prolapsed cord and retained placenta will be discussed subsequently together with the role of the anaesthetist in their management.

REFERENCES

1 Romney S L. Reid D E Metcalf J and Burwell C S (1955) Oxygen utilization by the human fetus in utero *Amer J Obstet Gynec* 70 791

2 Crawford, J S (1956) Some aspects of obstetric anaesthesia *Brit J Anaesth*, 28 201

3 Cleland, J G P (1933) Paravertebral anaesthesia in obstetrics experimental and clinical basis. *Surg Gynec Obstet* 57 51

4 Seward E H and Bryce-Smith R. (1957) *Inhalation Analgesia in Childbirth* 1st ed. Oxford Blackwell.

5 Gibberd, G F (1955) *Short Textbook of Midwifery* 6th ed. p 142 London Churchill.

In addition to the above the following works have been frequently consulted during the preparation of the present chapter

1 Marx G F and Orkin, L. R. (1958) Physiological changes during pregnancy a review *Anesthesiology* 19 258

2 Hingson, R. A and Hellman, L. M. (1956) *Anesthesia for Obstetrics* 1st ed Philadelphia Lippincott

3 Brews A. (1957) Eden and Holland s *Manual of Obstetrics* 11th ed. London Churchill.

hypertension interference with renal function placental infarction and retroplacental haemorrhage

In severe cases the diminished renal output will be such as to lead the anaesthetist to limit his choice of drugs in the manner suggested previously (part 6) There is strong support in obstetric circles for the suggestion that the renal failure and the hypertension result at least in part from renal cortical arteriolar constriction initiated by a utero-renal reflex similar to the Trueta-shunt phenomenon The possible role of the anaesthetist in the treatment of such a condition and in the treatment of eclampsia will be discussed later in this book.

In the presence of pre-eclampsia the anaesthetist must assume that there is a significant diminution in the efficiency of oxygen transport from mother to child This can result from three causes gross placental infarction haemorrhage into the placental site diminution in the rate of maternal blood-flow through the decidual vessels Whatever reason pertains it behoves the anaesthetist to take care that he does not decrease maternal oxygenation by his choice of analgesia or anaesthesia The more active measures he can take to counteract the effects of placental deficiency will be discussed later

b Multiple Pregnancy

Multiple pregnancies tend to result in the delivery of small premature infants Furthermore toxaemia of pregnancy occurs relatively frequently in association with this condition Thus an extra attention to the details of maternal oxygenation is indicated The first stage of labour is often prolonged on account of weak and infrequent uterine contractions according to Gibberd [5] who also teaches that the persistence of this uterine inefficiency during the second-stage leads frequently to the necessity of a forceps-assisted delivery despite the small size of the foetus

In the case of twin pregnancy there is usually an interval of about twenty minutes between delivery of the first infant and the resumption of uterine contractions During this period if there is any placental separation it is likely to be only slight

It is rarely that the presenting foetus does not lie longitudinally The second infant however is frequently not so conveniently situated. If the obstetrician has not been able to carry out a version on the second twin before the membranes rupture the mother will probably have to be anaesthetized for the operation.

Possibly because of the excessive stretching to which the uterus is subject during pregnancy there is an increased risk of inadequate retrac-

tissue of foetal origin It encloses a broad, swiftly-running current of maternal blood, and lies within the uterine cavity being fed from arterioles which pass through the myometrium from the uterine and ovarian arteries and drained by a comparable venous system In any area of adjacency the maternal blood flows in a direction opposite to that taken by the foetal stream[3] This description pertains to conditions existing after about the thirtieth week of pregnancy

The specificity and rate of placental transmission are governed by the following factors

I. The effective extent of the placental site
II. The rates of flow of both foetal and maternal blood.
III. The permeability of the endothelial barrier
IV The partial gas-pressure osmotic pressure and hydrostatic pressure gradients across the endothelium.
V The relative concentrations of electrolytes
VI The capacity of the placenta to undertake active transmission

At term the placental site is generally circular in outline with a diameter of about 6-8 inches However it has by this time passed its peak of efficiency The process of placental degeneration normally begins to reach significant proportions at about the thirty-eighth week of pregnancy It consists of a progressive obliterative endarteritis of the foetal vessels which by causing a coagulative necrosis of the chorionic villus leads to the appearance of localized placental infarcts representing discreet areas of fusion of such necrosed villi Concomitant with, though distinct from, the areas of infarction are localized areas of haemorrhage into the placenta. In these regions the villi have been destroyed or disorganized by haemorrhage from the maternal aspect of the choriodecidual space The process of ageing of the placenta thus leads directly to a reduction of the efficiency of the organ by diminishing its area of activity Starting between one and three weeks before term degeneration continues progressively and thus becomes of considerable significance when pregnancy is prolonged beyond the expected date of delivery A recent study[4] has suggested that the placenta ages much more rapidly at least between the thirty-sixth and fortieth weeks when the maternal Rh blood-group is negative A similar picture of placental infarction and haemorrhage of variable severity is associated with toxaemia of pregnancy essential hypertension and chronic nephritis Placenta praevia is the remaining notable condition in which the placental site might be drastically diminished.

It is convenient to consider the factors of the hydrostatic pressure

CHAPTER II

THE PLACENTA

a General Considerations

PLACENTAL function is the crux of most problems in obstetric anaesthesia. It is by way of this fascinating organ that the foetus receives its oxygen, its nourishment and its share of drugs administered to and abnormal substances produced by the mother The placenta also provides virtually the sole route of excretion open to the foetus Some recent studies[1, 2] have indicated that certain substances might pass between the chorion laeve and the foetus via the amniotic fluid, but for the moment these matters lie outside the range of this book. The differential manner in which the placenta regulates its two-way traffic, the factors influencing the degree and selectivity of its action and, in great measure the norms of such action are woefully ill-understood. However the sum of facts and hypotheses regarding the subject has progressively increased since Barcroft initiated serious research into the physiology of the placenta, and recently—notably in New York—a determined attack has been made on many of the problems The anaesthetist is especially concerned with questions regarding foetal respiration, and with the possibility of placental transference of the drugs which he administers to the mother An approach to these problems necessitates some understanding of the physiology and pathology of the placenta.

It is now considered that the placenta is an organ of internal secretion, possibly acting also as a storehouse for various products necessary to foetal metabolism. These matters are of little practical concern to the anaesthetist, to whom the organ is represented solely as a vast area of juxtaposition of the maternal and foetal circulations Foetal blood passes from the umbilical arteries to the umbilical vein by way of a huge network of capillary loops contained within the chorionic villi. The latter are lined only by a syncitial epithelial layer and bathed in the maternal blood of the intervillous spaces In the mature placenta, the intervillous spaces coalesce to a marked degree, forming what is termed the chorio-decidual space This initially maternal structure is bounded on one side by chorionic

arterio-venous difference in oxygen content of the umbilical vessels is close to that of the uterine vessels the blood flow of the two circulations should, in accordance with the Fick principle be of the same order, namely 500 ml per minute We have no means of controlling either the rate of blood-flow or the hydrostatic pressure within the foetal capillaries of the placenta.

The influence of molecular size and ionic charge upon the degree of permeability of the placenta is apparently of little immediate practical concern to the anaesthetist as there exists no well-founded theoretical exposition of these matters which can be applied to the problems of drug transference * What is known empirically about the behaviour of each drug is detailed in the second half of this chapter

It is unlikely that the factors of osmotic equilibrium and electrolytic concentration play any significant part in the transmission of anaesthetic agents

The placental transmission of gases is obviously of pressing interest to the anaesthetist. Details regarding the anaesthetic agents will be discussed in the general section on drugs preceded by a consideration of the passage of oxygen and carbon dioxide.

It has been demonstrated[9] that placental transmission ceases on completion of delivery and before the cord is cut but is still in progress between the times of delivery of the presenting part and of the conclusion of the second stage of labour Thus there can never be any point in attempting to oxygenate the child via its mother once delivery is complete and nor is there any danger to the child in giving the mother more anaesthetic at this stage Cord pulsation is not indicative of continuity between maternal and foetal circulations though of course there might be a dwindling store of oxygen within the placenta on which the apnoeic infant might usefully draw No studies of the time of cessation of transmission in cases of Caesarean section have been reported, but it would obviously be of interest to know this

b Placental Transmission of the Respiratory Gases

Foetal survival is dependent upon the oxygen supply received via the placenta, and upon the efficiency with which carbon dioxide is passed to the maternal circulation along the same route The mechanics of the two circulations as described above provide a gross control of the rate

* For a review of aspects of this subject with reference to the influence of toxaemia the reader is referred to McGaughey H. S Jones H. C Talbert L and Anslow W P (1958) *Placental transfer in normal and toxic gestation* *Amer J Obstet Gynec* 75 482

gradient and the rates of blood flow together According to Page[5] between uterine contractions the pressure within the foetal capillaries is 30–35 mm Hg and that in the chorio-decidual space is 5–10 mm Hg During a contraction both pressures rise to maintain this gradient coincidentally ensuring that the circulation of foetal blood does not cease Page concludes that hydrostatic pressure plays no part in the transfer of any substance either way However, changes in the local maternal circulation must influence the rate of flow of blood within the chorio-decidual space There is increasing evidence replacing previous speculation that placental transmission is altered in conditions affecting the afferent sinuses of this space These conditions include notably toxaemia of pregnancy essential hypertension uterine hypertonia and spinal and epidural block. As previously indicated, both pre-eclamptic toxaemia and essential hypertension may reduce the extent of the effective placental site by producing areas of infarction. Lately it has been demonstrated by Johnson and Clayton[6] amongst others, that in severe toxaemia placental function is much improved by an epidural block. Obviously such a block is unlikely to cause a reversal of the process of pathology in the infarcted areas It can be effective only by relieving the constriction of uterine vessels which is a characteristic of the condition Similarly part of the considerable relief of foetal distress afforded by epidural block during the strong contractions—and throughout the prolonged labour—of cases of incoordinate uterine activity have been attributed to uterine vaso-dilatation.[6, 7] Payling Wright and her colleagues[7] further believe that even in the course of normal labour fairly strong uterine contractions by interrupting blood-flow through the afferent vessels of the chorio-decidual space can temporarily reduce placental transmission of oxygen. Indeed, foetal bradycardia—possibly signifying foetal hypoxia—is frequently observed at the height of a contraction and is well-recognized as being associated with sustained uterine hypertonicity under conditions of prolonged spinal analgesia. Variation in the calibre of the uterine arterioles whether of intrinsic or extrinsic origin leads to altered transmission from mother to child, not by changing the hydrostatic pressure within the chorio-decidual space but by affecting the rate of blood-flow In cases of protracted uterine vaso-constriction the flow of blood through the intervillous spaces becomes so sluggish that the pathological process of infarction is initiated.

Other than the self-evident effects of compression of the umbilical cord, little is known regarding the factors influencing the rate of blood-flow through the foetal capillaries Romney and his co-workers[8] have suggested, on the basis of findings quoted later in this chapter that as the

arterio-venous difference in oxygen content of the umbilical vessels is close to that of the uterine vessels the blood flow of the two circulations should, in accordance with the Fick principle be of the same order namely 500 ml per minute We have no means of controlling either the rate of blood-flow or the hydrostatic pressure within the foetal capillaries of the placenta.

The influence of molecular size and ionic charge upon the degree of permeability of the placenta is apparently of little immediate practical concern to the anaesthetist as there exists no well-founded theoretical exposition of these matters which can be applied to the problems of drug transference * What is known empirically about the behaviour of each drug is detailed in the second half of this chapter

It is unlikely that the factors of osmotic equilibrium and electrolytic concentration play any significant part in the transmission of anaesthetic agents

The placental transmission of gases is obviously of pressing interest to the anaesthetist. Details regarding the anaesthetic agents will be discussed in the general section on drugs, preceded by a consideration of the passage of oxygen and carbon dioxide.

It has been demonstrated[9] that placental transmission ceases on completion of delivery and before the cord is cut but is still in progress between the times of delivery of the presenting part and of the conclusion of the second stage of labour Thus there can never be any point in attempting to oxygenate the child via its mother once delivery is complete and nor is there any danger to the child in giving the mother more anaesthetic at this stage Cord pulsation is not indicative of continuity between maternal and foetal circulations, though of course there might be a dwindling store of oxygen within the placenta on which the apnoeic infant might usefully draw No studies of the time of cessation of transmission in cases of Caesarean section have been reported, but it would obviously be of interest to know this

b Placental Transmission of the Respiratory Gases

Foetal survival is dependent upon the oxygen supply received via the placenta, and upon the efficiency with which carbon dioxide is passed to the maternal circulation along the same route The mechanics of the two circulations as described above provide a gross control of the rate

* For a review of aspects of this subject with reference to the influence of toxaemia the reader is referred to McGaughey H S Jones H C. Talbert L and Anslow W P (1958) Placental transfer in normal and toxic gestation *Amer J Obstet Gynec* 75 482

and quantity of these transfers The conditions existing at the maternal foetal interface merit further discussion

Aspiration of blood from the intervillous space is now an established technique [6] and thus analysis of the maternal blood involved in the process of placental transmission can be obtained with considerable accuracy The difficulties of obtaining blood samples from the foetal capillaries have however proved much more intractable and it has been customary to rely upon analysis of umbilical vein blood, taken at the moment of delivery as giving a fairly reliable reflection of the conditions existing in utero In the course of two noteworthy articles Apgar and her col leagues[10, 11] have suggested that the partial pressure of oxygen found in the umbilical vein at birth will be lower than that which had obtained in the villous capillaries immediately prior to delivery The difference it is postulated is due to interference with placental transmission during parturition subsequent to the analgesia—whether regional or general—and to physical factors associated with the mechanics of delivery These workers indicate that the partial pressure of oxygen within the umbilical vein of a normal infant at the time of delivery is about 50 mm Hg

Barron and Meschia [12] and later Page [6] presented the following equation relating to the rate of oxygen transference across the placenta

$$Q = D\ W\ (P_1 - P_2)$$

where Q is the total quantity of oxygen transferred from mother to child each minute

D is the diffusion coefficient for oxygen expressed in mg /kg of foetus per mm Hg difference in pO_2

W is the weight of the foetus in kilograms

P_1 P_2 are the average values for the partial pressure of oxygen in maternal and foetal blood respectively

Commenting on this equation Page noted that P_1 will always exceed P_2 for two reasons there is a rapid withdrawal of oxygen from the foetal blood by the foetal tissues and secondly the dissociation of foetal oxyhaemoglobin occurs at a lower pO_2 than does the dissociation of adult oxyhaemoglobin lower even than that of the pregnant woman The latter point is of further importance for the corollary holds true foetal haemoglobin has an increased affinity for oxygen in the high partial pressure range and consequently when compared with adult haemoglobin has an increased capacity to take up oxygen at the placental site

Page discusses the equation in the light of results published by Romney and his colleagues [8] These workers analyse their findings in 13 cases of Caesarean section performed under spinal analgesia and present the following figures

Uterine blood-flow	assessed at 500 ml /min
Foetal weight	average 3 300 gm
Placental weight	average 500 mg
Weight of myometrium	average 1,500 gm

	Average Oxygen Content (*ml* /100 *ml*)
Uterine artery	15 2
Uterine vein	10 5
Umbilical artery	3 5
Umbilical vein	8 0

Romney s group considers the oxygen consumption of the placenta and of the myometrium to be about 4 5 ml /kg /min Thus from a total uterine consumption of 23 5 ml. oxygen per minute the foetal demand accounts for about 5 0 ml./kg /min

Reverting to the equation the following may be substituted Q=16 5 W=3 3, $(P_1 - P_2) = 37$ and thus D=0 135 (Page in obtaining a result of D=0 2 is considering the transfer of oxygen from the uterine artery to the uterus and its contents)

The values quoted by Romney and his co-workers appear to indicate that the uterine circulation carries oxygen in considerable excess of the foetal requirements at term Gross disruption of the placental site would undoubtedly interfere seriously with the passage of oxygen to the foetus as already indicated, but the above-quoted figures lend some point to the more recent views on post-maturity expressed notably by Bancroft-Livingston and Fisher[15] These workers claim that other things being equal, there is no evidence of an association between post-maturity and foetal hypoxia, and that the increased perinatal mortality rate attendant upon post-maturity is a reflection of other factors namely disproportion excessive size of the infant, and prolonged labour As the debate is still proceeding the possibility of a relationship between post-maturity and foetal hypoxia will continue to be pressed.

Assuming that there is maximal flow of maternal blood through the choriodecidual space and that its haemoglobin is fully oxygenated the amount of oxygen presented to the foetus can be increased only by adding to the quantity of oxygen dissolved in the plasma McClure[4] claims that this can be done by allowing the mother to breathe pure oxygen He presents the argument that 100 ml of adult blood contains 0 25 ml of oxygen and 1 04 ml of nitrogen in the dissolved state and that thus by replacing the nitrogen with oxygen an additional 1 0 ml of oxygen per

100 ml of maternal blood is made available to the foetus McClure goes on to say that as the arterial blood of the neonate is usually 50 per cent saturated with oxygen (an estimate rather lower than that suggested by Page[5] and by James and his colleagues[10 11]) and the foetal oxyhaemoglobin dissociation curve is steep in the vicinity of 50 per cent saturation this slight increase in maternal pO_2 will result in a significant rise in the oxygenation of the foetal blood. He reports a series of 15 mothers undergoing normal delivery under pudendal block. They were given 10 l of *100 per cent oxygen via a closely-fitting B L B mask for an average of* 45 minutes prior to delivery The infants in the series had a mean umbilical vein pO_2 of 38 21 mm. Hg whilst the comparable figure in a control series of 19 mothers who breathed air but were otherwise similarly treated, was 28 93 mm. Hg

That maternal inhalation of a high oxygen concentration might benefit the foetus was first suggested nearly thirty years ago [15] and the therapy is now generally practised in cases of foetal distress

Carbon Dioxide

As stated in the previous chapter the patient at term has a low partial pressure of carbon dioxide in her blood (pCO_2) and a low concentration of buffer base (42 mEq/l) compared with that of the normal adult The findings presented from Apgar s Unit[10 11] in the articles previously referred to indicate that the blood of a normal foetus at term exhibits the same tendencies In response to the transient anoxaemia associated with delivery per vaginum the neonate rapidly develops a marked degree of respiratory acidosis but metabolic acidosis does not occur unless the *period of anoxaemia is prolonged. The fall in pCO_2 following adequate* oxygenation of the newborn infant is of equal rapidity In view of the fact that under conditions of adequate oxygenation foetal pCO_2 and buffer base concentration are both maintained at about the levels found in maternal blood, it would seem that the placenta permits the very rapid diffusion of carbon dioxide from foetus to mother without the incentive of a steep gradient It is also apparent that the foetus is not as has so often been claimed used to a high partial pressure of carbon dioxide in utero These matters will be referred to again in Chapter VI

c The Placental Transmission of Anaesthetic Agents

Our routines of anaesthesia need modification when applied to the obstetric case The basic feature necessitating this modification is the fact that in such a case there are two subjects involved one of whom can

usefully be regarded as a poor risk patient The anaesthetist can be in only indirect communication with his second, more vulnerable patient Just as it is upon the pharmaco-physiology of the placenta that the development of the foetus of a healthy mother depends so also it is upon the transmitting attributes of the placenta that many of our rules in obstetric anaesthesia fundamentally hinge Yet even today little is known regarding the placental filtration or active transport of our analgesic and anaesthetic agents from maternal to foetal circulation Equally important is the fact that we are also ignorant of the time-factor involved in many instances.

A fairly cursory perusal of the literature indicates that the first laboratory evidence of placental transmission of a drug in which we are interested was published in 1907 Snyder[16] states that Holzbach in that year showed *scopolamine* to be already present in a child s urine when delivery occurred 15 minutes after injection of the drug into the mother the route of administration not being indicated. Fifty years later we find that there has been virtually no progress in our knowledge of the possible transmission of other drugs having a primary action at the autonomic nerve endings. Page[3] has stated that monoamine oxidase in the placenta probably breaks down *adrenaline* and *noradrenaline* as they leave the maternal circulation and that thus these agents do not reach the foetus Zacks and Wislocki[1] have shown that there is present in the placenta a large store of cholinesterase though for some reason as yet unexplained, the acetyl cholinesterase and serum cholinesterase of the placenta are comparatively resistant to prostigmine. We remain completely ignorant regarding the possible entry into the foetal circulation of other para-anaesthetic agents If *scopolamine* why not *atropine* and, of even greater importance especially in respect to the conduct of spinal and epidural analgesia, why not the *vaso-pressor agents?* We appear to know nothing regarding either the degree or rate of transference of these drugs yet in the presence of established foetal distress their exhibition could conceivably be a final determining factor on the outcome of the case

The tale as regards the inhalational anaesthetic agents is somewhat brighter In 191_ Whipple (quoted by Snyder[18]) recorded his observations that, following *chloroform* anaesthesia for delivery concentration of the drug in foetal maternal and placental blood was about the same There is no record of any subsequent confirmation of this work. Although Whipple makes no comment on time factors it can probably be correctly assumed that there is only a very short interval between commencement of induction of anaesthesia and the passage of chloroform to the infant

Smith and Barker[19] in 1942 published the results of their observations on the placental transmission of *ether* They concluded that the relation between maternal and foetal blood ether levels was generally, though not always individually a directly proportional one The low amounts which were found in the umbilical arterial blood suggested that the foetal tissues received less ether than did the maternal These workers made significant note of the possibility of trans-amniotic passage of ether from maternal to foetal circulation and also of the pos ible propensity of the placenta for storing ether thereby aiding the production of a gradient These two matters though beyond the scope of this book, obviously merit considerable thought and investigation Again as with chloroform there is no intimation of the rapidity with which ether first reaches the foetus but presumably the delay is equally short

The only analytical study of the passage of *nitrous oxide* is recorded in another earlier article by Smith[20] He quotes only four figures which are said to be the average of an unspecified number of assays—times are not mentioned Smith studied the volumes per cent of nitrous oxide in foetal and maternal bloods The figures for maternal arterial and venous blood were 28 0 and 21 7 respectively and for umbilical vein blood and umbilical artery blood 13 5 and 9 8 respectively The striking feature of these figures is the steep maternal/foetal gradient Further investigation of this problem might serve to clarify the picture

The picture regarding *cyclopropane* is rather confused—and confusing Smith[20] in the same article as the one just referred to reported the following findings

Sample taken from	*Volumes per cent cyclopropane*
Maternal artery	7 5
Maternal vein	6 7
Umbilical vein	6 0
Umbilical artery	5 1

It will be observed that the foetal concentration is about 75-80 per cent of the maternal blood level and that no times are discussed Rovenstine[1] in 1955 said that the foetal blood concentration of cyclopropane approached that of the mother s blood only after 15-20 minutes but he gave no details of investigations supporting this Hingson and Hellman[2] state that the maternal cyclopropane blood level reaches 16-20 mg per cent in 10 minutes and that simultaneously the foetal blood levels (whether arterial or venous is not indicated) rise to 13-16 mg per cent during the same period There are no details given of the number of cases

investigated, of the time elapsing before cyclopropane begins to appear in the foetal circulation, or of what happens after 10 minutes. Apgar and her co-workers[22] reported a study of 25 mothers to whom cyclopropane was given. They found, in 12 cases, that the amount of anaesthetic in the umbilical vein blood was usually less than, but was proportional to, the amount in the venous blood of a maternal extremity. As maternal arterio-venous studies suggested that the concentration of cyclopropane in the maternal tissues was not in equilibrium with that in the blood at the time of sampling, it was suggested that the maternal/foetal gradient was probably greater than that shown by comparison of maternal venous blood and umbilical vein blood. A source of confusion is inherent in the facts that, in this series, the cyclopropane was given briefly or intermittently and that a nitrogen washout technique was used in some cases. Again there was no suggestion of how much of a lag might be present.

It does appear that the placenta presents some form of partial barrier to the transmission of cyclopropane from mother to child. In view of Apgar's recent exposé[23] of the increased risks which the foetus runs when cyclopropane is used in obstetric anaesthesia, it would be as well if our knowledge could be more sharply defined on such matters as the time factor. A further matter, to which brief reference will be made later, concerns the possibility, and if so the rate, of re-transference of cyclopropane from foetus to mother.

Of the transmission of *trichlorethylene* (Trilene) by the placenta, virtually nothing is known. Helliwell and Hutton,[24] who were investigating the safety and potentialities of Trilene as an obstetric analgesic, discovered that in ewes which are given Trilene a higher concentration of the drug is attained in the foetal circulation than in the maternal circulation. However, these workers' supply of sheep failed, and they had to resort to using goats. In these animals the foetal blood concentration was found not to be higher than the maternal blood concentration. An important inference may be drawn from this. The application of results obtained in experiments in one species to the postulation of pharmaco-physiological processes in another is of very doubtful value in the study of the function of the placenta. We do not know how soon and to what extent Trilene reaches the foetus, nor do we know how significant is the high fat content of the full-term foetus in relationship to Trilene binding-power. Work by Roberts[25] seems to indicate that there is a slightly raised incidence of neonatal depression when Trilene is used, especially when pethidine is exhibited as an adjunct. How much of this is due to the production of mild maternal depression, with associated foetal hypoxia, remains to be discovered.

Our knowledge of the placental transmission of analgesics and sedatives presents a bizarre picture

Paraldehyde according to Snyder[16] readily passes into the foetal circulation The umbilical cord blood concentration at delivery is approximately the same as that in the maternal blood

Methylpentynol (Oblivon) was shown by Bourne[26] to be absent from cord blood at delivery, even though the mothers were given as much as 1 0 gm of the drug at 3-hourly intervals during the first stage of labour

Recently Katz and his co-workers[27] in a preliminary report have claimed on the basis of chemical analysis that *promethazine* does not penetrate the placental barrier Clinical experience to which reference will be made in the next chapter suggests that little if any, of the drug does indeed reach the foetus and that the same observation might be extended to cover all the *phenothiazine derivatives* in common use

Dihydrocodeine apparently does traverse the placenta according to Myers,[28] though no direct assays of drug levels were reported

The *narcotics* form an interesting part of the general theme Apgar and Papper[29] are the authors of the only paper in which reference is made to actual assays of *pethidine* the most widely used narcotic They state that the equivalent of 60–70 per cent of the maternal blood concentration of the drug is found in the blood of the newborn They give no details of measurement and do not refer to the time intervals involved Lund and Harris[30] discussed *heroin* They found no significant difference in the incidence of asphyxia of infants whether delivery occurred 1 2 3 or 5 hours after administration of the drug to the mother Referring primarily to *morphia* McNab[31] has written that the peak of opiate action on the foetus occurs 90–120 minutes following administration of the drug to the mother and that some depressive action may be observed even 4 hours after This is the traditional view but it has not received the support of pharmacological investigation On the basis of extensive clinical observation it is generally accepted that pethidine should be given not less than 2 hours and morphia not less than 3 hours prior to the expected time of delivery and that appreciable quantities of these drugs do reach the foetus Recently increased favour has been accorded the view that provided these drugs are given within 15–20 minutes of delivery they will not reach the foetus in significant amounts This important deviation remains to be justified by analysis of cord blood Furthermore it should be noted that McNab[31] claims elsewhere in his article that *N-allylmorphine* (Nalline) readily traverses the placenta and he advises that it be given intramuscularly or intravenously to the mother

at least 5 minutes before delivery, if it is suspected that the child might be depressed by a narcotic. It is hard to believe that the small change in molecular structure which converts Nalline to morphia is sufficient to lead to a prolongation of the interval of transmission from under 5 minutes to 15-20 minutes Although *levallorphan*/pethidine and levallorphan/*alphaprodine* (Nisentil) mixtures are currently advocated we know nothing of the rate and extent of transmission of this antidote Of possible significance in this respect is a detail in the work on pethidine/levallorphan mixtures reported by Roberts[32] Infants of mothers who received their last injection of the mixture 3½ hours prior to delivery were on the whole more depressed than those whose mothers received their final dose closer to the time of delivery Possibly there is a differential rate of metabolism by the foetus favouring the more rapid destruction of levallorphan but possibly too levallorphan finds a more easy transit to the foetus than does pethidine. Gilliam and his colleagues[33] appear to favour extending the safe period of narcotic administration to one hour In reporting a study involving pethidine and Nisentil they state that asphyxiated infants were never encountered in the 20 per cent of their patients who were delivered within one hour of the time of their last dose of either analgesic agent.

Regarding the other group of antagonists Holmes[34] claims that *amiphenazole* (Daptazol) crosses the placenta, as administration of the drug to mothers under his care counteracted morphine-induced depression in the foetus The time factor was not indicated. No work has been reported on the possible antagonism by Daptazol and *Megimide* of barbiturates in the foetal tissues

The position regarding the transmission of the *barbiturates* themselves is becoming clearer Snyder[16] implies that all barbiturates cross the placenta very promptly once they have entered the maternal blood-stream A number of workers[35, 9] have in the past three or four years shown that *thiopentone sodium* administered intravenously to the mother appears in the foetal circulation certainly within 2-3 minutes—thereafter the level of concentration in the two blood-streams remains equal falling in an exponential manner provided, of course that the drug is not given repeatedly The old 8 10 11 or 12 minutes rules—unfortunately still laboured in authoritative textbooks and articles—are falsely premised and must be abandoned. If a single dose of thiopentone is used in obstetric surgery it does not call for a hurried delivery Indeed, it may be argued that the longer the time elapsing before delivery occurs the less likely is the child to suffer from depression of barbiturate origin

Recently Flowers[36] showed that *sodium barbital* traverses the placenta

very quickly, and that maternal and foetal concentrations soon achieve equality falling gradually over a period of 15 hours or longer

Ploman and Perssons[37] using the 4-7 months foetuses involved in therapeutic terminations of pregnancy demonstrated that *amylobarbitone phenobarbitone* and *barbitone* all crossed the placental barrier without delay, although in the case of amylobarbitone administered intramuscularly about 30 minutes elapsed before the level of foetal blood concentration reached that of the maternal concentration.

Fealy[38] has shown that the placental transference of *pentobarbital sodium* (Nembutal) occurs almost immediately following intravenous injection of the drug The foetal blood concentration level is 74 per cent of the maternal concentration within 1 minute The foetal and maternal blood levels persist at the same equilibrium for at least 185 minutes

Nyberg and his colleagues[39] have demonstrated that when *vinbarbital sodium* is administered to the mother prior to delivery concentrations of *the drug in maternal blood and in cord blood rapidly become almost* equal.

Happily with the exception of one or two dissidents there is general and informed agreement on the question of the transfer of the *muscle relaxants* It had been tacitly assumed, since Gray s[40] original work, that *d-tubocurarine* did not pass the placenta. Crawford[9] showed that this was indeed the case, by analysis of specimens of cord blood in a relevant series of patients He was also able to demonstrate that *gallamine triethiodide* (Flaxedil) did reach the foetus though in very small—probably insignificant—amounts In view of the greater sensitivity of infants as compared with adults to the non-depolarizing relaxants [41] d-tubocurarine should be preferred to Flaxedil in obstetrics

The possible transmission of *succinylcholine* has not been investigated pharmacologically However there have been no ill-reports following its use in many thousands of cases Even if the drug did reach the foetus the rapidity of its breakdown would seem to guard against its producing neonatal depression especially in view of the infant s relatively raised tolerance to depolarizing agents

No thorough investigation of the possibility of the transference of *decamethonium iodide* has been undertaken Duchesne and his co-workers[4] are the only ones to have recorded doubt of the general assumption that this relaxant does not pass to the foetus in significant amounts However they used the drug as an adjunct to analgesia produced by pethidine and hyoscine and noted an increase (from 15 per cent to 27 per cent) in their rate of production of neonatal asphyxia when decamethonium was included. *There is no indication that they took steps to combat maternal*

sub-oxygenation and, under such circumstances their results must be viewed with extreme reserve

In conclusion the following general remarks might be thought worthy of consideration

If we agree that certain substances cross the placenta with ease then it is surely reasonable to postulate that the same substances are able to traverse the barrier in the opposite direction? If such is the case at what rate does the foetus rid itself of the non-metabolized drugs such as ether Trilene, cyclopropane and nitrous oxide, when administration to the mother has ceased?

Furthermore is it being rather precious to press the point and to inquire about the relative metabolic activities of the foetal and maternal organisms especially regarding liver function? And to note that excretion occurs only via the maternal organism? Perhaps the maternal liver can metabolize drugs such as the barbiturates and the narcotics more rapidly than can the foetal liver and some time after the initial administration of the drug a reverse gradient results Does this initiate a return of the drug from foetus to mother?

Some of these questions might seem of academic interest only Such might well be the case but so long as the sub-speciality of obstetric anaesthesia continues in its present uneasily-founded state no query which comes within its province can lightly be dismissed as being unworthy of investigation

REFERENCES

1 Brambell F W R (1954) Transfer of proteins across the fetal membranes Cold Spring Harbor Symposia on Quantitative Biology *The Mammalian Fetus* 19 71

2 Chinard F P (1954) Biochemical evaluation Cold Spring Harbor Symposia on Quantitative Biology *The Mammalian Fetus* 19 209

3 Browne J C McC (1954) Utero-placental circulation Cold Spring Harbor Symposia on Quantitative Biology *The Mammalian Fetus* 19 60

4 Shanklin D R (1958) 'The human placenta *Obstet and Gynec* 11 129

5 Page E W (1957) Transfer of materials across the human placenta *Amer J Obstet Gynec* 74 705

6 Johnson T and Clayton C G (1955) Studies in placental action during prolonged and dysfunctional labours using radioactive sodium *J Obstet Gynaec Brit Emp* 62 513

7 Payling Wright H Morris N Osborne S B and Hart A (1958) Effective uterine blood flow during labor *Amer J Obstet Gyne* 75 3

8 Romney S L Reid D E Metcalf J and Burwell C S (1955) Oxygen utilization by the human fetus in utero *Amer J Obstet Gynec* 70 791

9 Crawford J S (1956) Some aspects of obstetric anaesthesia *Brit J Anaesth* 28 146
10 James L S Weisbrot I M Prince C E Holaday D A and Apgar V (1958) Acid base status of human infants in relation to birth asphyxia and the onset of respiration *J Pediat* 52 379
11 Weisbrot I M James L S Prince C E Holaday D A and Apgar V (1958) Acid base homeostasis of the newborn infant during the first 24 hours of life *J Pediat* 52 395
12 Barron D H and Meschia G (1954) Comparative study of the exchange of the respiratory gases across the placenta Cold Spring Harbor Symposia on Quantitative Biology *The Mammalian Fetus* 19 93
13 Bancroft-Livingston G and Fisher O D (1958) Studies in prolonged pregnancy *J Obstet Gynaec Brit Emp* 65 147
14 McClure J H (1958) Newborn blood oxygen a method of increasing the partial pressure of oxygen in the blood of the newborn infant *Obstet and Gynec* 11 696
15 Waters R M and Harris J W (1931) Carbon dioxid and oxygen problems in obstetric anesthesia *Anesth & Analg* 10 59
16 Snyder F F (1949) *Obstetric Analgesia and Anesthesia* 1st ed p .61 Philadelphia Saunders
17 Zacks S I and Wislocki G B (1953) Placental esterases *Proc Soc exp Biol (N Y)* 84 438
18 Snyder F F (1949) *Obstetric Analgesia and Anesthesia* 1st ed p 331 Philadelphia Saunders
19 Smith C A and Barker R H (1942) Ether in the blood of the newborn infant *Amer J Obstet Gynec* 43 763
20 Smith C A (1939) Effect of obstetrical anesthesia upon the oxygenation of maternal and fetal blood with particular reference to cyclopropane *Surg Gynec Obstet* 69 584
21 Rovenstine E A (1955) In Report of Section of Anaesthesia of Australasian Medical Congress *Med J Aust* 2 577
22 Hingson R A and Hellman L M (1956) *Anesthesia for Obstetrics* 1st ed p 15. Philadelphia Lippincott
23 Apgar V Holaday D A James L S Prince C E and Weisbrot I M (1957) Comparison of regional and general anesthesia in obstetrics with special reference to transmission of cyclopropane across the placenta *J Amer med Ass* 165 2155
24 Helliwell P J and Hutton A M (1949) Analgesia in obstetrics *Anaesthesia* 4 18
25 Roberts H and Please N W (1958) Respiratory minute-volume in the newborn infant *J Obstet Gynaec Brit Emp* 65 33
26 Bourne G (1954) Methylpentynol in labour *Lancet* 2 522
27 Adelman M H Fisch J Jacobson E and Katz J (1958) Studies of promethazine with measurement of concentrations in venous blood fetal cord blood and cerebrospinal fluid. *Anesthesiology* 19 93
28 Myers J D (1958) Preliminary clinical evaluation of dihydrocodeine bitartrate in normal parturition *Amer J Obstet Gynec* 75 1096
29 Apgar V and Papper E M (1952) 'Transmission of drugs across the placenta *Anesth & Analg* 31 309

30 Lund C. and Harris J W (1943) Use of heroin in labor *Amer J Obstet Gynec* 45 980
31 McNab J A (1955) Obstetrical analgesia and anaesthesia *Canad med Ass J* 72 681
32 Roberts H Kane K M Percival N Snow P and Please N W (1957) Effects of some analgesic drugs used in childbirth with special reference to variations in respiratory minute volume of the newborn *Lancet* 1 128
33 Gillam J S., Hunter G W Darner C B and Thompson C R (1958) Meperidine hydrochloride and alphaprodine hydrochloride as obstetric analgesic agents *Amer J Obstet Gynec* 75 1105
34 Holmes, J M (1956) Amiphenazole in obstetric analgesia *Lancet* 2 765
35 McKechnie F B and Converse J C (1955) Placental transmission of thiopental. *Amer J Obstet Gynec* 70 639
36 Flowers, C. E. (1957) Placental transmission of sodium barbital *Obstet and Gynec* 9 332
37 Ploman, L. and Persson, B H (1957) On the transfer of barbiturates to the human foetus, and their accumulation in some of its vital organs *J Obstet Gynaec Brit Emp* 64 706
38 Fealy J (1958) Placental transmission of pentobarbital sodium *Obstet and Gynec* 11 342
39 Nyberg F F Kendrick J G Evans J A and Stofer B E (1958) Infant depression following Delvinal analgesia *Obstet and Gynec* 11 184
40 Gray T C (1947) d-Tubocurarine in Caesarean section *Brit med J* 1 444
41 Stead A L. (1955) Response of the newborn infant to muscle relaxants *Brit J Anaesth* 27 124
42 Duchesne R. Lamontagne A Lacasse J Laradis R Sirois P and Bernier A (1956) Barbiturates in obstetrics effects on the newborn *Canad Anaesth Soc J* 3 97

CHAPTER III

ANALGESIA

THE *method of relieving pain in labour has formed almost as controversial* a topic as has the question of anaesthesia itself in obstetrics There seems little point in here recounting yet again details of the history of obstetric analgesia or alluding to the international flavour of the debate Chapter II contains an account of the anatomy and physiology of pain in labour the present chapter will be concerned with methods of relief contemporarily in common use in Britain

a Sympathetic Reassurance

The confidence of the patient is a prime factor in the success of any method of analgesia The most knowledgeable and adept doctor or midwife will have to work very much harder—and even so often unsuccessfully—to achieve some relief for a patient who is unprepared uncomprehending and terrified than will be necessary for one who has been well-rehearsed in the active role which she must play in her labour The exhortations and crusades of Grantley Dick Read are well enough known to need no recounting here It is appreciated that some women of greater or lesser intelligence can by following the Dick Read regime successfully carry through labour and delivery without recourse to analgesics More important to our thesis however it must be acknowledged that the call for analgesia is greatly diminished in patients who have been sympathetically prepared in a manner allied to the Dick Read technique Possibly the original evangelistic tone should be modified *somewhat specifically with regard to the promise of absolute freedom* from pain or discomfort (a fault in technique which is shared equally by exponents of methods differing radically from that of Dick Read) Once confidence has been shattered by even one overwhelmingly painful contraction it is extremely difficult to re-establish a rapport by the hasty use of analgesic drugs if no preliminary proviso had been made regarding their possible exhibition There is no doubt that many individuals will break down under stress however well-prepared they have been to meet

it, and the culmination of a pregnancy must be accepted as being a stressing experience The patient must be confident in the knowledge that supplementary analgesia will be available to her without recrimination or reluctance—should her own efforts fail to relieve the tension which according to Dick Read, is the basis of the pain of labour

Confidence is rarely an expression of blind faith but rather a product of education An opportunity is offered by the attendance of the majority of pregnant women in Britain at the Ante-natal Clinics to discuss with each the process of labour and delivery How often this benefit is conferred upon those not attending the Clinics is unknown Usually a senior Sister, the obstetric registrar, or possibly a consultant obstetrician conducts the Analgesia class' in the Clinic. Too rarely is an anaesthetist involved As the obstetric anaesthesia service of the country evolves this must undoubtedly be remedied.

In the Analgesia lectures, expectant mothers are told what they are likely to experience during the course of a normal labour and delivery and, of equal importance they are given a simple account of the relationship between cause and effect To a greater or a lesser degree, depending upon the prevailing medical temper in each particular area or hospital, they are taught how best they can ally themselves with the progress of labour the better to avoid or to diminish pain-provoking tensions The range of analgesic drugs used by the hospital is reviewed, and the patients are allowed to acquaint themselves with the odours of nitrous oxide and Trilene Apparatus is demonstrated, and every woman should be allowed to realize the feel of a mask on her face

Each patient for whom there is an increased possibility of abnormal labour should have special instruction This should be concerned notably with the type of anaesthesia she is likely to encounter, and with the avoidance of heavy meals when labour is felt to be imminent

b Inhalational Techniques

Nitrous oxide remains the foundation upon which is built the whole structure of analgesia in British obstetric practice This was so for many years even before 1933 when Minnitt[1] evolved a gas-air apparatus which could be sanctioned for use by unsupervised midwives Since that time, it has held undisputed sway but there are indications that its place in routine schemes will soon be shared by Trilene

The outstanding advantage of nitrous oxide over all other analgesic agents is its great flexibility combined with a very high safety factor when it is used in the approved manner Because of the rapid produc-

tion of analgesia and the equally rapid dissipation of the drug at the end of administration the pain of each contraction can be combated as an entity On a theoretical basis this is a much more rational approach than is the swamping of the entire period of labour and delivery in an aura of analgesia produced by the repeated injections of such drugs as pethidine or by regional block techniques Although the latter methods are in many cases superior in the efficiency with which they counteract the painful peaks of contraction we must be realistic and humble enough to admit that when employing such techniques we are exposing our patients to drugs for which during many hours in each labour, they have no requirement This is a situation possibly unique in the field of medicine and it adds greatly to our responsibility for any adverse side-reactions

Other than nitrous oxide Trilene is the only agent in common employment as an intermittent analgesic Aspects of the history methods of administration associated apparatus and contraindications regarding the two drugs have been recounted in many publications The subject was admirably presented recently by Seward and Bryce-Smith and there seems little point in recapitulating all the details here Therefore there follows only a summary of the important aspects of inhalational analgesia

Midwives may administer nitrous oxide only when the gas is mixed with an equal quantity of air Consequently the machines which the anaesthetist will meet in most units—and in domiciliary practice—are those which deliver such a mixture and are approved by the Central Midwives Board They are

Minnitt gas-air analgesia apparatus
Jecta gas-air analgesia apparatus
Talley gas-air analgesia apparatus

The C M attachment which permits an initial inhalation of two or three breaths of pure nitrous oxide is not authorized by the Central Midwives Board for use by midwives

Trilene vapour may be administered in a range of concentration up to 0 45-0 55 volume per cent in air and the machines delivering such quantities must continue to do so within a reasonable range of respiratory activity on the part of the patient and under variations of room temperature from 55° F to 95° F The machines so far endorsed by the Board are

The Tecota Mark 6 trichlorethylene inhaler
The Emotril Automatic trichlorethylene analgesia inhaler

Fifty per cent nitrous oxide in air administered in the approved fashion may be used without fear of untoward effects for all healthy women

undergoing normal labour. Trilene in air is equally safe in most of such cases but, due to the cumulative action of the drug, there is the possibility that continuous administration, for more than about six hours, might result in some drowsiness on the part of the mother and an associated degree of foetal depression.

The use of 50: 50 nitrous oxide and air obviously entails the intermittent inhalation of a 10 per cent oxygen mixture. In patients who have symptoms associated with heart disease or anaemia, this method of producing analgesia might well prove dangerous, and is better avoided. Similarly, patients in whom there is likely to exist considerable placental deficiency associated with pre-eclamptic toxaemia, post-maturity and possibly severe hypertension or diabetes, should preferably not be permitted this form of analgesia. In all such cases, Trilene/air or medically supervised 50: 50 nitrous oxide/oxygen analgesia, is not contraindicated.

In all cases, if the mother becomes unduly excited, distressed or drowsy or if signs of foetal distress appear, administration of the analgesic mixture should be immediately discontinued and the position reassessed.

Seward and Bryce-Smith[2] suggest that Trilene/air gives a more satisfactory degree of analgesia than does 50: 50 nitrous oxide/air, and is equivalent in analgesic potency to 75: 25 nitrous oxide/oxygen. The latter mixture is not available for use by midwives, but can be employed advantageously by the anaesthetist.

Finally, the danger of soda-lime contamination with previously inhaled Trilene should be borne in mind whenever a general anaesthetic becomes imperative.

c. Systemic Agents

Pethidine hydrochloride has assumed the same stature in the field of systemically administered analgesics as that of nitrous oxide in inhalational techniques. The main effort to produce a precise delineation of the place of pethidine in obstetric practice has been undertaken by Hilda Roberts.[3] The general rules which she originally published as those used for guidance in the Obstetric Department of the Postgraduate Medical School of London are still followed. They are: (1) labour must be established before administration of the analgesic: uterine contractions must be of good amplitude and occur at regular intervals; (2) dilatation of the os uteri must have reached at least three fingers in a primipara and two fingers in a multipara.

In the article just quoted, Roberts suggested giving scopolamine with each dose of pethidine in an effort to decrease the rate of failure to produce analgesia. In a series reported subsequently, scopolamine was omitted,

and this is the usual practice today Scopolamine appears not to increase the chances of obtaining adequate analgesia with sufficient significance to justify its use in the face of its propensity to produce maternal disorientation However there is here a point to be noted pethidine is not a completely reliable analgesic in labour and workers in general agree that given as the sole agent it will fail in 5-10 per cent of cases When used in combination with nitrous oxide/air the failure rate is apparently 4-5 per cent

Pethidine is usually given in doses of 100 mg though it is apparent that in many centres the initial dose, at least has crept up to 150 mg The timing of subsequent doses must depend upon the progress of labour The second dose may be given about one hour later if progress is satisfactory and thereafter at three-hourly intervals until about two hours before the predicted time of delivery As with all drugs given by injection the intramuscular route should be used unless intravenous administration is indicated It is neither safe nor rational to give subcutaneous injections —which so often are found to be in reality placed intradermally—as the rate of absorption from this site and hence the period of activity of the drug is completely unreliable

It is generally agreed that 100 mg pethidine exerts a respiratory depressant action about equal to that obtained with morphia gr $\frac{1}{6}$ (10 mg) In the mother this action will inevitably lead to a mild degree of anoxaemia and a slight carbon dioxide retention especially if the drug is administered repeatedly over a long period Such maternal reactions cannot fail at least to tend to produce deleterious effects upon the foetus This aspect of pethidine analgesia has not been studied probably for the reason that it would be difficult to differentiate such effects from those produced by the placental transmission of the drug The effect of maternal respiratory depression is likely to be significant in a proportion of cases and the situation must not be tolerated The likelihood of resulting sub-oxygenation is undoubtedly increased if nitrous oxide/air analgesia is being used to supplement the pethidine and under these circumstances close watch must be kept for evidence of foetal distress

Recent reports[4, 5] indicate that when pethidine is given in dosages as suggested above to supplement nitrous oxide/air analgesia about 15 per cent of infants will suffer significant depression of respiration Roberts and her colleagues[4] showed that on the average a diminution of 10-15 per cent in the minute volume of the newborn infant occurred if pethidine was added to the basic nitrous oxide/air scheme of analgesia. Such findings are not lightly to be discounted and they together with earlier impressions of a similar nature have led to dissatisfaction with the simple pethidine/

nitrous oxide/air technique and to a search for means of avoiding or of combating the central depression

Because of the greater analgesic effect of Trilene in air, as compared with that of 50 50 nitrous oxide/air, use of the former results in a slight reduction in the amount of pethidine needed to produce an equi-analgesic effect. However even with the diminished total dose of pethidine there is no doubt that a rate and degree of foetal depression of severity approximately equivalent to that obtained with pethidine/nitrous oxide/air results from the use of the pethidine/Trilene routine It is most unwise to give a routine initial dose greater than 100 mg pethidine in conjunction with Trilene and subsequent doses—given in response to the same indications as when nitrous oxide/air inhalational analgesia is used—should for safety be limited to 75 mg at a time

The administration of phenothiazine derivatives to supplement, and coincidentally to reduce, the use of pethidine is becoming increasingly popular Chlorpromazine (Largactil) and promethazine (Phenergan) are the drugs most commonly employed. Each is given by intramuscular injection in a dosage ranging from 25 mg to 50 mg

The phenothiazine derivatives are said to exert a selective depressant action upon the brain-stem reticular formation Clinically their exhibition leads to a varying degree of sedation often associated with amnesia, a general diminution of autonomic tonal activity a specific deterrence of nausea and vomiting and a potentiation of the action of other sedatives and analgesics Chlorpromazine has been shown to cause liver damage—occasionally fatal—following a prolonged course of administration, but although in very rare instances a similar result has been claimed as following a single dose, the hepatotoxic effect of the drug is probably of no significance in obstetric practice

Reports on the use of chlorpromazine in labour appeared earlier than those on promethazine and are more numerous The former drug will therefore be discussed first. There is fairly general agreement that the use of chlorpromazine permits a reduction in the previously established dosage scheme of pethidine without causing loss of analgesia There is no authoritative account in the English literature of the potentialities of chlorpromazine as the sole relieving agent in labour and there would seem to be little justification for pursuing such an investigation There are varied views regarding the direct effect of chlorpromazine on the progress of labour Caldeyro-Barcia and his colleagues[6] have suggested that the drug in no way alters the force and frequency of contractions Initially several workers[7, 8] reported that labour was prolonged and that the forceps-rate was increased under the influence of chlorpromazine

due to the mother's decreased awareness of her surroundings and her consequent lack of co-operation It is probable that these views resulted from an early tendency to overdosage and it is now generally agreed[9, 10] that if the duration of labour is altered in any way it is more probably decreased, due to the enhanced relaxation (vide Dick Read) of the mother

The effects of chlorpromazine in terms of neonatal well-being are still not completely assessed. On the whole because of the narcotic-sparing action of the drug infants of mothers given chlorpromazine/pethidine are probably as lively as those in a series in which pethidine alone has been used in conjunction with nitrous oxide/air or with Trilene Indeed it has been suggested[11, 12, 13] that in a large series the former group of infants will show less depression However it must be accepted that there has been an unpleasantly large number of instances in which gross neonatal depression has followed the use of a chlorpromazine/pethidine mixture Some of these must undoubtedly have resulted from abuse of the narcotic which must at all times be given more sparingly when used in this combination Other causes have probably been associated with an unexpectedly high potentiation of pethidine and the possibility of this occurrence must cause considerable uneasiness in the minds of doctors charged with the control of these patients A third suggested explanation of the sporadic encountering of undue neonatal depression has to do with an important side-action of chlorpromazine itself—namely the production of hypotension

In various reports [13] hypotension has been cited as a feature noted in up to 33 per cent of obstetric patients who have been given chlorpromazine In many cases the hypotension is mainly orthostatic and by ensuring that the patient lies flat her blood pressure can be maintained at the normal levels However this leads to obvious difficulties in many cases

It is well known that a fall of maternal blood pressure from any cause during labour inevitably tends to lead to foetal distress It should be realized therefore that the price of using this extremely impressive augmentation to obstetric analgesia might well be very high in terms of perinatal morbidity and mortality It is likely that in practice it will be abandoned in favour of the other phenothiazine derivatives

Promethazine potentiates narcotic analgesics and sedatives almost to the same degree as does chlorpromazine In addition although it does tend to produce some measure of dissociation the effect is much less pronounced than that obtained with the latter drug [14] and mothers given comparable doses of promethazine appear to be considerably more amenable to direction and encouragement [8] As with chlorpromazine—though apparently to a lesser degree—there is the danger of untoward

potentiation of pethidine by promethazine The outstanding difference is however that neither the degree of hypotension nor the rate of appearance of this side-effect is nearly as marked with promethazine as with chlorpromazine[14]

In consequence of the foregoing it will be found that whilst the effects of the two drugs on the course and symptoms of labour are about the same promethazine is considerably less liable to lead to perinatal depression than is chlorpromazine to which it is thus to be preferred No hepatotoxic effects have been noted as following the administration of small amounts of promethazine

It cannot be too strongly stressed that when used in combination with a phenothiazine derivative the dose of pethidine must be reduced from the normal range A reduction of 40–50 per cent is advocated

Despite the finding previously referred to that chlorpromazine has no effect upon uterine contractibility there is evidence that if given early in the first stage it completely inhibits the progress of labour[10] Presumably promethazine shares this property It follows that the phenothiazine derivatives should be withheld until such time as the first injection of pethidine is indicated The initial dose of either chlorpromazine or promethazine should be not more than 50 mg With this is given 50–75 mg pethidine depending upon the weight of the patient Pethidine may be repeated at 3-hourly intervals in doses of 25–50 mg with the usual provisos The phenothiazine derivative should be given with every alternate pethidine injection in a dose of 12 5–25 mg It is considered most unwise to give a total exceeding 100 mg of phenothiazine compounds in the course of a labour The normal careful observation accorded a woman in labour must be sharpened and if chlorpromazine has been chosen for use the liability of the production of sudden and alarming hypotension must be borne in mind

For the healthy patient undergoing normal labour the combination of pethidine and a phenothiazine derivative can be recommended for general use in both hospital and domiciliary practice and should be considered as an advance in therapy As previously stated promethazine is much to be preferred to chlorpromazine The combination may be used in association with Trilene/air or nitrous oxide/air analgesia but it will probably be found that there is a considerably diminished call for the inhalational agents except in very recalcitrant cases The use of promethazine should generally—and the use of chlorpromazine should specifically—be avoided in abnormal obstetric cases especially in the suspected presence of placental insufficiency It is quite possible that promethazine will be shown to be of great advantage in such patients

due to the mother s decreased awareness of her surroundings and her consequent lack of co-operation It is probable that these views resulted from an early tendency to overdosage and it is now generally agreed[9, 10] that if the duration of labour is altered in any way it is more probably decreased, due to the enhanced relaxation (vide Dick Read) of the mother

The effects of chlorpromazine in terms of neonatal well-being are still not completely assessed. On the whole because of the narcotic-sparing action of the drug infants of mothers given chlorpromazine/pethidine are probably as lively as those in a series in which pethidine alone has been used in conjunction with nitrous oxide/air or with Trilene Indeed it has been suggested[11, 12, 13] that in a large series the former group of infants will show less depression However it must be accepted that there has been an unpleasantly large number of instances in which gross neonatal depression has followed the use of a chlorpromazine/pethidine mixture Some of these must undoubtedly have resulted from abuse of the narcotic which must at all times be given more sparingly when used in this combination Other causes have probably been associated with an unexpectedly high potentiation of pethidine and the possibility of this occurrence must cause considerable uneasiness in the minds of doctors charged with the control of these patients A third suggested explanation of the sporadic encountering of undue neonatal depression has to do with an important side-action of chlorpromazine itself—namely the production of hypotension

In various reports [13] hypotension has been cited as a feature noted in up to 33 per cent of obstetric patients who have been given chlorpromazine In many cases the hypotension is mainly orthostatic and by ensuring that the patient lies flat her blood pressure can be maintained at the normal levels However this leads to obvious difficulties in many cases

It is well known that a fall of maternal blood pressure from any cause during labour inevitably tends to lead to foetal distress It should be realized, therefore that the price of using this extremely impressive augmentation to obstetric analgesia might well be very high in terms of perinatal morbidity and mortality It is likely that in practice it will be abandoned in favour of the other phenothiazine derivatives

Promethazine potentiates narcotic analgesics and sedatives almost to the same degree as does chlorpromazine In addition although it does tend to produce some measure of dissociation the effect is much less pronounced than that obtained with the latter drug [14] and mothers given comparable doses of promethazine appear to be considerably more amenable to direction and encouragement [8] As with chlorpromazine—though apparently to a lesser degree—there is the danger of untoward

levallorphan and in addition to its action in opposing directly-induced neonatal depression the drug will also be of benefit in the avoidance of secondary depression subsequent to maternal sub-oxygenation and hypercapnia

There are no data available on the effective dosage of levallorphan necessary to counteract narcotic depression in the presence of phenothiazine derivatives It is possible that the levallorphan/pethidine ratio might have to be increased slightly under such circumstances

It should be noted that the specific narcotic antagonists and the phenothiazine derivatives all oppose the tendency of pethidine to produce nausea and vomiting As pethidine-induced emesis has been variously reported as occurring in 10–25 per cent of cases[18] this property is of considerable significance in the pursuit of maternal comfort

Amiphenazole is not a specific narcotic antagonist It has excited considerable interest as a possible direct antagonist to the action of barbiturates on the central nervous system in addition to its postulated effect as an inhibitor of narcotic-induced depression Despite the work of the Melbourne School[19, 20] there is still general doubt regarding the precise site and mode of action of the drug Speculation persists that it is a general central nervous system excitor Overdosage can certainly lead to evidence of central nervous stimulation and this is not a property calculated to encourage the routine use of the drug in obstetrics Holmes[21] has recommended that 30 mg amiphenazole be given with each injection of morphia gr $\frac{1}{4}$ (16 mg) With such a mixture he claims that an analgesic effect equal to that of 130 mg pethidine is obtained As he had previously found 150 mg pethidine to be equivalent in analgesic activity to morphia gr $\frac{1}{4}$ he concludes that amiphenazole does diminish to some degree the pain-relieving quality of narcotics Furthermore the antagonist does not oppose the tendency of morphia to produce nausea and vomiting In his report Holmes concludes that when given in the doses recommended amiphenazole reduces but does not entirely eliminate the incidence of neonatal apnoea caused by morphia It would appear that levallorphan is a better choice of antagonist in obstetric anaesthesia

Scopolamine has had an honoured place in obstetric practice since the introduction by Gauss of the concept of twilight sleep It has commonly been given intramuscularly together with pethidine in doses of gr $\frac{1}{150}$ (0 4 mg) The general routine has been to repeat the administration of scopolamine gr $\frac{1}{150}$ at a time with each subsequent dose of pethidine omitting the former drug if the mother shows signs of becoming disorientated or unco-operative and also if delivery is expected within the forthcoming two hours As Roberts[3] has indicated administration of

but for the moment the investigation of this must be left in the hands of well-trained observers in special centres

Recently a third phenothiazine derivative promazine (Trilafon, Sparine) has been favourably reported on in the United States[15] Compared with the other two it is said to be less toxic and to be several times more effective as an analgesic potentiator It is still too early to make even an initial assessment of the place of this drug in obstetric practice

The narcotic antagonists are assuming increasing importance in obstetric practice There are three members in general use levallorphan (Lorfan) nalorphine (Lethidrone Nalline) and amiphenazole (Daptazole)

Levallorphan and nalorphine are specific narcotic antagonists acting centrally as substrate competitors at the cell surface They may be given by either intramuscular or intravenous injection and their rate of onset of activity is about equal to that of similarly administered pethidine or morphia. The duration of their activity specifically in relation to the question of neonatal depression has not been convincingly demonstrated (see Chapter II and below) It is generally agreed that whilst opposing the central depressant action of narcotics these drugs do not greatly affect the degree of analgesia or of sedation produced. There is one important difference between the actions of the two drugs Levallorphan even when given in considerable quantity appears to exert no deleterious effect upon the patient If on the other hand nalorphine is given alone or is over-titrated against a narcotic respiratory depression can result[16 17] There seems, therefore to be every justification for abandoning this drug in favour of levallorphan Should nalorphine be preferred, it is usual to give 5 mg for each 100 mg pethidine

Reference has already been made (in Chapter II) to the somewhat anomalous findings of Roberts and her co-workers[4] in their investigation of the effects of the combined administration of pethidine and levallorphan As has been suggested these phenomena might be due in part to an inadequate dose of the antagonist It is advisable to maintain a ratio of 1 mg levallorphan to 100 mg pethidine Levallorphan can usefully *be given intravenously if delivery is imminent and narcotic-induced* neonatal depression is feared. Under such circumstances the drug must be given at least 15 minutes before delivery if full effect is to be achieved (see Chapter II) The dosage is 1 mg for there is absolutely no point in stint There should be little reason however for such an emergency to arise Sufficient evidence now exists to favour the teaching that levallorphan be given with each dose of pethidine with or without an accompanying dose of promethazine There is no danger involved in the use of

levallorphan and in addition to its action in opposing directly-induced neonatal depression the drug will also be of benefit in the avoidance of secondary depression subsequent to maternal sub-oxygenation and hypercapnia

There are no data available on the effective dosage of levallorphan necessary to counteract narcotic depression in the presence of phenothiazine derivatives It is possible that the levallorphan/pethidine ratio might have to be increased slightly under such circumstances

It should be noted that the specific narcotic antagonists and the phenothiazine derivatives all oppose the tendency of pethidine to produce nausea and vomiting As pethidine-induced emesis has been variously reported as occurring in 10-25 per cent of cases[18] this property is of considerable significance in the pursuit of maternal comfort

Amiphenazole is not a specific narcotic antagonist It has excited considerable interest as a possible direct antagonist to the action of barbiturates on the central nervous system in addition to its postulated effect as an inhibitor of narcotic-induced depression Despite the work of the Melbourne School[19, 20] there is still general doubt regarding the precise site and mode of action of the drug Speculation persists that it is a general central nervous system excitor Overdosage can certainly lead to evidence of central nervous stimulation and this is not a property calculated to encourage the routine use of the drug in obstetrics Holmes[21] has recommended that 30 mg amiphenazole be given with each injection of morphia gr ¼ (16 mg) With such a mixture he claims that an analgesic effect equal to that of 130 mg pethidine is obtained. As he had previously found 150 mg pethidine to be equivalent in analgesic activity to morphia gr ¼ he concludes that amiphenazole does diminish to some degree the pain-relieving quality of narcotics Furthermore the antagonist does not oppose the tendency of morphia to produce nausea and vomiting In his report Holmes concludes that when given in the doses recommended amiphenazole reduces but does not entirely eliminate the incidence of neonatal apnoea caused by morphia It would appear that levallorphan is a better choice of antagonist in obstetric anaesthesia

Scopolamine has had an honoured place in obstetric practice since the introduction by Gauss of the concept of twilight sleep It has commonly been given intramuscularly together with pethidine in doses of gr $\frac{1}{150}$ (0 4 mg) The general routine has been to repeat the administration of scopolamine gr $\frac{1}{150}$ at a time with each subsequent dose of pethidine omitting the former drug if the mother shows signs of becoming disorientated or unco-operative and also if delivery is expected within the forthcoming two hours As Roberts[3] has indicated administration of

scopolamine within two hours of delivery can lead to some respiratory depression of the infant The two principal reasons for the use of scopolamine in labour have been firstly to achieve some slight potentiation of a simultaneously exhibited narcotic analgesic and secondly to promote a degree of amnesia for the more unpleasant episodes Promethazine offers a greater degree of certainty in the production of narcotic potentiation and a wider margin of safety than does scopolamine Furthermore, unpleasant side-effects notably dryness of the mouth and a tendency to disorientation are much less likely to occur with promethazine than with scopolamine It is probable that the place of the latter in common practice will be taken by promethazine or an allied drug

The barbiturates have a well-defined function in the management of labour Their role will not be fulfilled unless it is remembered that this class of drugs possesses no analgesic properties If barbiturates are relied upon as the sole medication at times of severe pain a state of unmanageable excitement is likely to result The place of these drugs is complementary to that of the analgesics previously discussed in this chapter They should primarily be used to promote rest for the mother in the early stages of labour especially at night If a primipara starts in labour at any time between the late afternoon and early morning (6 p m to 4 a m would be a useful rule-of-thumb guide) a barbiturate will serve admirably to give her a good rest before regular strong contractions begin At other times of day probably a better plan is to give chloral hydrate gr 30 The mother will probably not be able to sleep or wish to do so during the daytime either at home or in hospital, and the latter drug is more likely than are the barbiturates to produce a refreshingly quiet sedation When a multipara is first seen in labour it is advisable to assess the rate of progress for an hour or two before deciding upon giving a barbiturate If the first stage seems likely to last for several more hours then treatment should be instituted as outlined above

In multipara and primipara barbiturates are also indicated when the first stage is prolonged progress remains slow and the mother is tiring or is losing confidence It is in such a situation that many practitioners consider morphia (gr $\frac{1}{6}$-$\frac{1}{4}$ 11-16 mg) or Omnopon (gr $\frac{1}{3}$) to be specifically indicated, as these drugs possess both sedative and analgesic qualities of great potency If under such circumstances an opiate is given it would be advisable to reduce the suggested dose if a phenothiazine derivative has been previously administered it is also advisable that levallorphan (1 mg for morphia gr $\frac{1}{6}$ 1 25 mg for Omnopon gr $\frac{1}{3}$) be given at the same time

The use of barbiturates in the treatment of eclampsia and of severe

pre-eclampsia will be mentioned in a later chapter, but the matter is more the prerogative of the obstetrician than of the anaesthetist

The barbiturates in common use are quinalbarbitone sodium (Seconal) pentobarbitone sodium (Nembutal) and butobarbitone sodium (Soneryl) The recommended dosage of each varies between gr 1½ (100 mg) and gr 4½ (300 mg) depending upon the weight of the patient and the degree of apprehension she exhibits The actual choice of barbiturate usually depends more upon the personal preference of the midwife in charge or on the tradition in the department than upon slight variations between the pharmacology of each product There is really little significant difference between the three All doctors newly entering upon a Department or a General Practice would be well-advised to accept the established regime In general it must be admitted that most sedatives and analgesics tend to appear to be more effective if the Ward Sister has faith in them Her prejudice or hostility can often wreck a theoretically sound scheme of therapy

Barbiturates should be avoided during the second half of labour especially if possible during the period 4-6 hours prior to delivery

Recently methylpentynol (Oblivon) has achieved some popularity as a mild ataractic and as a potentiator of analgesic drugs Roberts[4] has lately substantiated Bourne's[22] observations on this drug Given orally in water 6 drachms (about 20 ml) of the Elixir—a dose which was repeated if the patient vomited within 10 minutes—appeared to be helpful in diminishing the stress of early labour Later in labour subsequent doses of 3-6 drachms apparently increased the analgesic activity of nitrous oxide/air and of pethidine In the dosage given the drug seemed to produce no deleterious effect upon the infant Notable maternal side-effects were drowsiness in 40 per cent of cases (though this might be considered a highly desirable side-effect early in labour) euphoria (28 per cent) and vomiting within 10 minutes of receiving the drug (10 per cent) Vomiting occurs in a comparable percentage of cases even when the drug is administered within a capsule though a repeat dose according to Bourne is usually retained Whitehouse[23] reports that in an effort to avoid this unpleasant action the rectal route of administration has been adopted in the Birmingham Maternity Hospital and by general practitioners within the vicinity with very satisfactory results However there is a well-ingrained and understandable prejudice against giving drugs per rectum during labour and it seems unlikely that Whitehouse's suggestion will become generally accepted

Methylpentynol is neither an analgesic nor an anti-spasmodic Apart from helping to enhance the action of the analgesics its main attribute

scopolamine within two hours of delivery can lead to some respiratory depression of the infant The two principal reasons for the use of scopolamine in labour have been firstly to achieve some slight potentiation of a simultaneously exhibited narcotic analgesic and secondly to promote a degree of amnesia for the more unpleasant episodes Promethazine offers a greater degree of certainty in the production of narcotic potentiation and a wider margin of safety than does scopolamine Furthermore unpleasant side-effects notably dryness of the mouth and a tendency to disorientation are much less likely to occur with promethazine than with scopolamine It is probable that the place of the latter in common practice will be taken by promethazine or an allied drug

The barbiturates have a well-defined function in the management of labour Their role will not be fulfilled unless it is remembered that this class of drugs possesses no analgesic properties If barbiturates are relied upon as the sole medication at times of severe pain a state of unmanageable excitement is likely to result The place of these drugs is complementary to that of the analgesics previously discussed in this chapter They should primarily be used to promote rest for the mother in the early stages of labour especially at night If a primipara starts in labour at any time between the late afternoon and early morning (6 p m to 4 a m would be a useful rule-of-thumb guide) a barbiturate will serve admirably to give her a good rest before regular strong contractions begin At other times of day probably a better plan is to give chloral hydrate gr 30 The mother will probably not be able to sleep or wish to do so during the daytime either at home or in hospital and the latter drug is more likely than are the barbiturates to produce a refreshingly quiet sedation When a multipara is first seen in labour it is advisable to assess the rate of progress for an hour or two before deciding upon giving a barbiturate If the first stage seems likely to last for several more hours then treatment should be instituted as outlined above

In multipara and primipara barbiturates are also indicated when the first stage is prolonged progress remains slow and the mother is tiring or is losing confidence It is in such a situation that many practitioners consider morphia (gr $\frac{1}{6}$–$\frac{1}{4}$ 11-16 mg) or Omnopon (gr $\frac{1}{3}$) to be specifically indicated, as these drugs possess both sedative and analgesic qualities of great potency If under such circumstances an opiate is given it would be advisable to reduce the suggested dose if a phenothiazine derivative has been previously administered it is also advisable that levallorphan (1 mg for morphia gr $\frac{1}{6}$, 1 25 mg for Omnopon gr $\frac{1}{3}$) be given at the same time

The use of barbiturates in the treatment of eclampsia and of severe

pre-eclampsia will be mentioned in a later chapter but the matter is more the prerogative of the obstetrician than of the anaesthetist

The barbiturates in common use are quinalbarbitone sodium (Seconal) pentobarbitone sodium (Nembutal) and butobarbitone sodium (Soneryl) The recommended dosage of each varies between gr 1½ (100 mg) and gr 4½ (300 mg) depending upon the weight of the patient and the degree of apprehension she exhibits The actual choice of barbiturate usually depends more upon the personal preference of the midwife in charge or on the tradition in the department than upon slight variations between the pharmacology of each product There is really little significant difference between the three All doctors newly entering upon a Department or a General Practice would be well-advised to accept the established régime In general it must be admitted that most sedatives and analgesics tend to appear to be more effective if the Ward Sister has faith in them Her prejudice or hostility can often wreck a theoretically sound scheme of therapy

Barbiturates should be avoided during the second half of labour especially if possible during the period 4-6 hours prior to delivery

Recently methylpentynol (Oblivon) has achieved some popularity as a mild ataractic and as a potentiator of analgesic drugs Roberts[4] has lately substantiated Bourne's[22] observations on this drug Given orally in water 6 drachms (about 20 ml) of the Elixir—a dose which was repeated if the patient vomited within 10 minutes—appeared to be helpful in diminishing the stress of early labour Later in labour subsequent doses of 3-6 drachms apparently increased the analgesic activity of nitrous oxide/air and of pethidine In the dosage given the drug seemed to produce no deleterious effect upon the infant. Notable maternal side-effects were drowsiness in 40 per cent of cases (though this might be considered a highly desirable side-effect early in labour) euphoria (28 per cent) and vomiting within 10 minutes of receiving the drug (10 per cent) Vomiting occurs in a comparable percentage of cases even when the drug is administered within a capsule though a repeat dose according to Bourne is usually retained. Whitehouse[23] reports that in an effort to avoid this unpleasant action the rectal route of administration has been adopted in the Birmingham Maternity Hospital and by general practitioners within the vicinity with very satisfactory results However there is a well-ingrained and understandable prejudice against giving drugs per rectum during labour and it seems unlikely that Whitehouse's suggestion will become generally accepted.

Methylpentynol is neither an analgesic nor an anti-spasmodic Apart from helping to enhance the action of the analgesics its main attribute

is that of a mild tranquillizer with some emphasis on sedation. As such its place in early labour is probably the same as that suggested for chloral hydrate. In addition it might usefully be given in place of a barbiturate to relatively less apprehensive patients or to those who are known to react in an undesirable way to the latter group of drugs. The bitter taste of methylpentynol, its tendency to produce vomiting and the significant volume of fluid which its administration entails combine to make its place in the later stages of labour less well-defined.

In summary there is here presented a suggested scheme for the management of pain and distress in labour. Under no circumstances is rigid observation to be encouraged. At all times therapy must be related to the condition of the individual patient, to her weight, and to the state of the foetus.

A Scheme of Obstetric Analgesia

During Pregnancy Education and reassurance

During Labour

First Stage

A. From inception of labour to onset of regular, strong contractions (corresponding roughly to a dilatation of 3 fingers in primipara and 2 fingers in multipara)

1 General nursing care to combat uneasiness: the provision of comfortable attractively furnished day-rooms well-stocked with books and magazines, and including a television set and a wireless is implicit in the term nursing care

2 Chloral hydrate gr 30 or methylpentynol 6 drachms during day

3 A barbiturate, gr 1½–4½ at night.

4 If this period is prolonged, or discomfort becomes excessive 100 mg pethidine or morphia gr ¼ (plus 1·0 mg levallorphan in either case) may be substituted for or added to (2) or (3)

B From onset of well-established labour to end of first stage

1 Initial i.m. dose pethidine mg 50–75
levallorphan mg 0·75–1·0
promethazine mg 25–50

Subsequent i.m. doses pethidine (mg 25–50) plus levallorphan (mg 0·5–0·75) at 3 or 4-hourly intervals and accompany alternate injections with promethazine (mg 12·5–25). Total dose of promethazine not to exceed 100 mg

2 If peaks of contractions still provoke pain do not hesitate to use inhalational analgesic

Second Stage

1 Intermittent inhalational analgesia one injection of pethidine/levallorphan mixture may be given and promethazine added if it was omitted from the previous injection

2 During delivery
Continuous inhalational analgesia (preferably Trilene in air) from the time the attendant takes over control of delivery to completion of delivery of the shoulders

Third Stage

Preferably a few breaths of Trilene

NOTES AND PRECAUTIONS

1 In the presence of foetal distress and when there is evidence or suspicion of placental insufficiency (e.g cases of maternal hypertension or gross anaemia pre-eclamptic toxaemia post-maturity history of previous unexplained still-birth) the use of 50 50 nitrous oxide/air and of the phenothiazine derivatives is contraindicated.

2 In cases of heart disease causing symptoms towards the end of pregnancy the use of 50 50 nitrous oxide/air, and of chlorpromazine is contraindicated.

3 When there is a reasonable possibility that a general anaesthetic will be given using a closed-circuit technique Trilene should be avoided

4 If because of accompanying heart disease operative delivery is planned and the anaesthetist intends to use a closed-circuit he must himself be responsible for administering a 75 25 nitrous oxide/oxygen mixture whenever inhalational analgesia is required.

5 If the patient gives a history suggesting an undue reaction to barbiturates methylpentynol or morphia/levallorphan should be substituted. Porphyria presents an absolute contraindication to barbiturates

6 The anaesthetist should eagerly encourage and assist the obstetrician in guarding against maternal dehydration by the liberal use of intravenous transfusions Apart from the importance—especially in protracted labour[24] —on the grounds of general physiological principles this line of therapy not only counteracts a prominent cause of maternal discomfort in labour but it also helps to limit oral intake

7 Should the patient have had any corticosteroid therapy during the previous eighteen months she should be given prophylactic hydrocortisone on the lines used in general surgical cases[25] Routine inquiry of every obstetric patient should be made regarding this matter—and prominent note made of the positive replies—it is of increasing urgency

d Conduction Analgesia

Since the introduction of the technique of continuous caudal analgesia by Hingson and Southworth[26] in 1942 and its application to obstetrics by Hingson and Edwards[27] in 1943 use of the method for the control of pain in labour has been held in very popular esteem in North America Hingson s visit to Britain in 1949 stimulated renewed interest in the subject here [8] and led to much common-room discussion but the fact remains that regional analgesia for obstetrics is still out of favour in this country It is often a difficult and puzzling task to try to explain in honest terms to an American practitioner why this should be A contribution to the debate may be found in the Introduction to this book and in this and the two succeeding chapters

If either caudal or lumbar epidural analgesia is embarked upon an in-dwelling catheter technique should be employed No local analgesic even with added adrenaline is likely to be effective for more than three hours after injection and a scheme of repeated epidural punctures is painful and potentially dangerous to the mother and laborious to the staff The technique and equipment associated with the administration of continuous epidural analgesia need not be discussed here—they must be in the armoury of every competent anaesthetist and are admirably described in several publications [29 30 31]

A note might usefully be inserted here however regarding the drugs to be employed and it can be taken to apply to all local techniques (other than spinal analgesia) discussed in this book Procaine (1 5 per cent) and Xylocaine (1-1 5 per cent) are the agents most generally used in the British Isles From published reports no authoritative indication regarding supplementation with adrenaline can be gleaned It is well-recognized that the admixture of adrenaline (used in a dilution of about 1 400 000) will oppose—usually effectively—the general systemic distribution of drugs injected into such a well-vascularized area as the epidural compartment By so doing adrenaline helps to reduce the number and severity of toxic reactions to local analgesics and also significantly prolongs analgesia It is highly unlikely that the adrenaline will effect the foetus (*see* Chapter II) and its use is *therefore to be recommended.* However care should be taken that the patient is not given cyclopropane or Trilene during the period of action of the drug

Xylocaine has achieved immense popularity in Britain because of the rapidity of onset of its action and because of its high spreading factor the latter allowing even the tyro to achieve gratifying success in the field of regional analgesia However as in the case of the other local analgesics

Xylocaine has on occasion produced unpleasant and often serious toxic effects Many of these episodes have not been generally publicized and will be heard of only in the course of personal discussion Only a part of the total dose of Xylocaine is destroyed in the liver the rest is excreted unchanged via the kidneys Hence in labour when renal flow is frequently diminished the possibility of toxic reactions due to the drug is increased, as is the chance of its passage across the placental barrier In recent years 2-chloroprocaine hydrochloride (Nesicaine) has been increasingly strongly advocated (notably by Foldes[30]) as the local analgesic of choice When this drug reaches the systemic circulation it is rapidly broken down by cholinesterase and thus its safety-factor is very high *It is recommended that 2-chloroprocaine be used in a 2 per cent solution* for local infiltration and 3 per cent for epidural block when mixed with 1 200 000 adrenaline it should be readministered at 50-minute intervals

An account of the anatomy and physiology of pain in labour will be found in Chapter II From this it will be appreciated that to obtain satisfactory results epidural analgesia introduced by either the lumbar or the caudal route must extend from the eleventh thoracic to the fourth sacral segments inclusive Extension upwards to T4 or T5 will halt the progress of labour

If epidural analgesia is instituted very early in labour progress usually ceases as the necessary stimulation to the initiation of motor activity is removed Hingson[9] teaches that continuous caudal analgesia should not be started until the presenting part is in the pelvis contractions lasting at least 40 seconds occur at not more than 3-minute intervals and the cervix is at least 2 fingers dilated in the multiparous patient and 3 fingers in the primipara.

The following contraindications to epidural analgesia are listed by Hingson[29]

1 Slow irregular and ineffective uterine contractions (but see later)
2 Obstructive factors to labour—foetal or maternal in origin
3 Severe haemorrhage
4 Hypotension
5 Infection at the site of injection
6 Lack of trained supervisors
7 Placenta praevia with haemorrhage

To the preceding are submitted the following additions

8 Known sensitivity on the part of the patient to local analgesics
9 Multiple pregnancy—Guttmacher[2] and Little and Friedman[33] have

recently shown that, under regional analgesia, the second twin is likely to suffer considerable depression at delivery

10 Probably all cases of suspect placenta praevia.

11 Maternal opposition.

12 C N S pathology

In reasonably skilled hands the failure rate with caudal analgesia is about 10 per cent—factors in this group include variation in local anatomy The failure rate is probably slightly less with lumbar epidural block, though with this method there is a greater chance of accidentally puncturing the dura. The proportion of failures is thus about the same following regional analgesia as when pethidine plus nitrous oxide/air analgesia is used. However in the event of failure after the insertion of an epidural needle it is more difficult to regain the mother s confidence than is the case when a projected scheme of systemic analgesia has to be supplemented.

Labour tends to be prolonged under the influence of conduction analgesia, and the rate of forceps deliveries undoubtedly rises sharply The latter result, of course occasions no displeasure or anxiety in most North American hospitals

The outstanding demands made by the regime of conduction analgesia are as follows

1 A doctor skilled in the management of these cases must constantly be present actually in the obstetric department. If the method is liberally employed, it will probably be found necessary to have two such doctors on duty

2 The progress of labour must carefully be watched for evidence of slowing

3 An unduly high level of analgesia must be guarded against by suitable positioning of the patient.

4. Partly as a corollary to (3) the blood-pressure must be carefully checked and recorded every half-hour after stabilization has been obtained following the initiation of analgesia. Hypotension is an ever-present possibility especially if the patient is permitted to sit (propped or not) for long periods. The immediate therapeutic measures are to lay the mother flat and to raise her legs.

5 Scrupulous attention must be paid the the bladder This organ is rendered insensible under conduction analgesia, and excessive filling occurs without the mother s knowledge The bladder may be kept reasonably free from distension by encouraging the mother to bear down strongly about every three hours assistance being given by

applying moderate suprapubic pressure. The alternative is repeated or continuous catheterization.

The foregoing discussion might serve to daunt the reader who contemplates introducing conduction analgesia into his practice. To promote such a response is not the object of the author. The method has many very significant attributes to its credit. Firstly, it ensures, as far as our knowledge goes at the moment, that after the initial stages of labour no depressant drugs are transmitted to the foetus. In cases where the infant's hold on life is precarious this can be a factor of inestimable importance. There is some suggestion[23] that in cases of prematurity or placental insufficiency the foetal salvage rate is higher when conduction rather than systemic, analgesia is employed. In fairness it must be noted that patients in the 'systemic analgesia' series are often subject to the rather heavier sedation and larger doses of analgesics traditional in American hospitals.

Secondly, conduction analgesia ensures an alert and co-operative mother. In the high proportion of cases which are carried through successfully the mother is completely free from apprehension and discomfort from the start of analgesia to the moment of delivery. However, a considerable number of patients do experience discomfort—sometimes rather distressing—during delivery. This can be avoided by infiltration of the perineum with a local analgesic.

It is thirdly of significant benefit to patients suffering from manifest cardiac insufficiency or from respiratory infection.

Fourthly, as Johnson[24] has stressed, continuous epidural analgesia offers considerable advantage in the management of prolonged labour due to disordered uterine function. It has been confidently reported that in cases of uterine inertia and cervical dystocia, the rate of progress in the first stage of labour is increased and the necessity of eventual Caesarean section decreased, by the use of conduction analgesia. In addition, as Johnson and Clayton[25] have pointed out, this treatment also helps to restore the associated impoverished placental circulation by dilatation of the decidual vessels. This important observation introduces a fifth attribute of epidural analgesia. There is good reason for supposing that placental insufficiency due to hypertension or to pre-eclamptic toxaemia is likely to be countered to a significant degree by the vaso-dilatation associated with conduction analgesia.

The following is a fair summary of the position as it appears to the author. In Britain amongst patients, doctors and nurses, tradition favours general analgesia for labour, and should be respected. A corollary of this fact is that the implementation of the techniques of general analgesia

on both a local and a national scale is at a laudably high level of effectiveness and safety, reducing in some measure the invidious comparison of these methods with regional techniques in North American practice The high forceps rate associated with conduction analgesia does not help to commend it to British obstetricians As outlined above, there are cases in which regional block offers significant advantages over general analgesia, all obstetric anaesthetists should be competent and their departments equipped to undertake conduction analgesia for such patients To extend the practice to a larger proportion of obstetric patients would entail a considerable reorganization of hospital and departmental administration and a re-orientation of our obstetric practice In terms of possible decreased maternal distress and perinatal morbidity, the returns if any, for such efforts would probably be insignificant

Epidural analgesia is not recommended for use in domiciliary practice Its place in operative obstetrics and in the treatment of eclampsia will be discussed in subsequent chapters

REFERENCES

1 Minnitt R J (1934) Self administered analgesia for the midwifery of general practice *Proc R Soc Med* 27 1313
2 Seward E H and Bryce-Smith R (1957) *Inhalation Analgesia in Childbirth* 1st ed Oxford Blackwell
3 Roberts H (1948) Pethidine and scopolamine in labour *Brit med J* 2 590
4 Roberts H Kane K M Percival N Snow P and Pleas N W (1957) Effects of some analgesic drugs used in childbirth with special reference to variation in respiratory minute volume of the newborn *Lancet* 1 128
5 Baker F J (1957) Pethidine and nalorphine in labour *Anaesthesia* 12 282
6 Caldeyro-Barcia R Poseiro J J Alvarez H and Tost P (1958) Action of chlorpromazine on uterine contractility and arterial pressure in normal and toxemic pregnant women *Amer J Obstet Gynec* 75 1088
7 Savage D (1955) Chlorpromazine as an analgesic in labour *Brit J Anaesth* 27 346
8 Carroll J J and Hudson I W (1955) Chlorpromazine and promethazine in obstetrics *Canad Anaesth Soc J* 2 340
9 Lindley J E Rogers S F and Moyer J H (1957) Analgesia potentiating effects of chlorpromazine during labour *Obstet and Gynec* 10 582
10 Browne A D H and Mannion P J (1955) Application of chlorpromazine to obstetrics with a study of its effects during labour *Irish J med Sci* 6th Ser No 351 p 117
11 Davies J I (1955) Use of largactil in obstetrics *Canad Anaesth Soc J* 2 327
12 Editorial (1956) Chlorpromazine in obstetrics *Lancet* 2 563
13 Harer W B (1956) Chlorpromazine in normal labor *Obstet and Gynec* 8 1
14 Gordon L E and Ruffin C I (1958) Promethazine as an adjunct to obstetrical analgesia and sedation *Amer J Obstet Gynec* 76 147

15 Wegryn S P and Marks R A (1958) Promazine meperidine and spinal anesthesia for labor and delivery *J Amer med Ass* 167 1918
16 Eckenhoff J E Elder J D and King B D (1952) N allyl normorphine in the treatment of morphine or demerol narcosis *Amer J med Sci* 223 191
17 Tenney S M and Mithoefer J C (1953) Respiratory depressant action of n allylnormophine in the normal subject and in patients with respiratory acidosis secondary to pulmonary emphysema *New Engl J Med* 249 886
18 Cilliam J S Hunter J W Darner C B and Thompson G R (1958) Meperidine hydrochloride and alphaprodine hydrochloride as obstetric analgesic agents *Amer J Obstet Gynec* 75 1105
19 Shulman A Shaw F H Cass, N M and Whyte H M (1955) A new treatment of barbiturate intoxication *Brit med J* 1 1238
20 Gershon S Bruce D W Orchard N and Shaw F H (1958) Amiphenazole and morphine in the production of analgesia *Brit med J* 2 366
21 Holmes J M (1956) Amiphenazole in obstetric analgesia *Lancet* 2 765
22 Bourne G (1954) Methylpentynol in labour *Lancet* 2 522
23 Whitehouse W L (1958) Rectal methylpentynol in labour Correspondence *Lancet* 1 743
24 Hawkins D F and Nixon W C W (1957) Blood electrolytes in prolonged labour *J Obstet Gynaec Brit Emp* 64 641
25 Dundee J W (1957) Anaesthesia and surgery in adrenocortical insufficiency *Brit J Anaesth* 29 166
26 Hingson R A and Southworth J L (1942) Continuous caudal anesthesia *Amer J Surg* 58 9-
27 Hingson R A and Edwards W B (1943) Continuous caudal analgesia in obstetrics *J Amer med Ass* 121 2-5
28 Editorial (1949) Caudal analgesia *Brit med J* 2 801
29 Hingson R A and Hellman L M (1956) *Anesthesia for Obstetrics* 1st ed Philadelphia Lippincott
30 Foldes F F Colavincenzo J E and Birch J H (1956) Epidural anesthesia a reappraisal *Anesth & Analg* 35 33 89
31 Bromage P R (1954) *Spinal Epidural Analgesia* 1st ed Edinburgh Livingstone
32 Guttmacher A F in Special Committee on Infant Mortality (1957) Panel discussion Obstetric anesthesia and analgesia *N Y St J Med* 57 2532
33 Little W A and Friedman E A (1958) Anesthesia for the twin delivery *Anesthesiology* 19 515
34 Johnson T (1957) Prolonged labour a clinical trial of continuous caudal analgesia *Brit med J* 2 386
35 Johnson T and Clayton, C G (1955) Studies in placental action during prolonged and dysfunctional labours using radioactive sodium *J Obstet Gynaec Brit Emp* 62 513

on both a local and a national scale, is at a laudably high level of effectiveness and safety reducing in some measure the invidious comparison of these methods with regional techniques in North American practice. The high forceps rate associated with conduction analgesia does not help to commend it to British obstetricians. As outlined above, there are cases in which regional block offers significant advantages over general analgesia all obstetric anaesthetists should be competent, and their departments equipped, to undertake conduction analgesia for such patients. To extend the practice to a larger proportion of obstetric patients would entail a considerable reorganization of hospital and departmental administration, and a re-orientation of our obstetric practice. In terms of possible decreased maternal distress and perinatal mortality the returns, if any for such efforts would probably be insignificant.

Epidural analgesia is not recommended for use in domiciliary practice. Its place in operative obstetrics and in the treatment of eclampsia will be discussed in subsequent chapters.

REFERENCES

1 Minnitt, R. J (1934) 'Self-administered analgesia for the midwifery of general practice. *Proc. R. Soc Med.*, 27 1313
2 Seward, E. H. and Bryce-Smith, R. (1957). *Inhalation Analgesia in Childbirth.* 1st ed. Oxford. Blackwell.
3 Roberts, H. (1948) 'Pethidine and scopolamine in labour. *Brit. med. J.*, 2, 592
4 Roberts, H., Kane, K. M., Percival, N., Snow P and Please, N W (1957). 'Effects of some analgesic drugs used in childbirth, with special reference to variation in respiratory minute volume of the newborn. *Lancet*, 1, [illegible]
5 Baker F J (1957) 'Pethidine and nalorphine in labour *Anaesthesia*, 12, [illegible]
6 Caldeyro-Barcia, R., Poseiro, J J., Alvarez, H. and Tost, P (1958). Action of chlorpromazine on uterine contractility and arterial pressure in normal and toxemic pregnant women. *Amer J Obstet. Gynec.*, 75, 1088.
7 Savage, D (1955) Chlorpromazine as an analgesic in labour. *Brit. J Anaesth.*, 27 346.
8 Carroll, J J and Hudson, P W (1955) Chlorpromazine and promethazine in obstetrics. *Canad. Anaesth. Soc. J.*, 2, 340.
9 Lindley J E., Rogers, S. F and Moyer J H. (1957) Analgesia-potentiating effects of chlorpromazine during labour. *Obstet. and Gynec.*, 10 582.
10 Browne, A. D H. and Mannion, P J (1955). Application of chlorpromazine to obstetrics, with a study of its effects during labour *Irish J med. Sci.*, 6th Ser., No. 351 p 117
11 Davies, J L (1955) 'Use of largactil in obstetrics. *Canad. Anaesth. Soc. J.*, 2, 327
12 Editorial (1956) Chlorpromazine in obstetrics. *Lancet*, 2, 563
13 Harer W B (1956) Chlorpromazine in normal labor. *Obstet. and Gynec.*, 8, 1
14. Gordon, L. E. and Ruffin, C. L. (1958) 'Promethazine as an adjunct to obstetrical analgesia and sedation. *Amer J Obstet Gynec.*, 76, 147

anaesthetic agent in obstetric practice The advantages claimed on its behalf are

(1) In terms of general toxicity and central depression it offers a relatively high degree of safety for the mother
(2) Satisfactory anaesthesia can be obtained together with adequate oxygenation
(3) It is one of the very few drugs which will provide relaxation of the uterus without at the same time causing dangerous maternal depression
(4) Should vomiting occur it is likely to do so in a light plane of anaesthesia, when the laryngeal reflexes are still able to offer some protection against the aspiration of vomitus
(5) It demands no cumbersome apparatus when used in general practice

The disadvantages of ether may be classified as

(1) It is frequently the cause of neonatal depression
(2) It is notorious for provoking vomiting during induction or the recovery period.
(3) Given as the sole agent, it is likely to be associated with a prolonged and tempestuous induction
(4) It is explosive and inflammable
(5) It is unpleasant to take

Dominant opinion in Britain is probably still in favour of ether as the mainstay in obstetric practice Ether has been used as the sole anaesthetic for so long that its name is almost synonymous with obstetric anaesthesia in the minds of not a few specialists and general practitioners It must always be acknowledged that in questions of safety the man behind the anaesthetic is of far greater significance than is the agent or method used. There is no doubt that there are many consultants and general practitioners who from their long experience of giving ether anaesthesia can by their skill in manipulating the drug ensure an irreducible degree of danger and discomfort for their patients For these artists—and the term is used with sincere respect—this book is not intended. It is aimed, rather to interest the younger generations of anaesthetists and general practitioners who are not satisfied with the standard of anaesthesia which they or their department can offer and for those who are concerned with the training of post-graduate and medical students The author is convinced that given equal standards of skill certainly a more pleasant and probably a safer anaesthetic can be given by using the more up-to-date techniques to be discussed, than by using ether

If ether is to be used, the mother must be given a belladonna derivative

CHAPTER IV

FORCEPS DELIVERY AND CAESAREAN SECTION

THE general aims by the satisfaction of which any method of anaesthesia for operative obstetrics must be judged, may be listed as follows

a Concerning the Mother

1 To provide a sure relief from pain
2 To provide continuous adequate oxygenation
3 To involve the minimal use of toxic drugs
4 To avoid the production of hypotension and vomiting and, if these should appear likely to occur to provide prophylaxis against their ill-effects
5 To provide satisfactory working conditions for the obstetrician
6 To provide maximum physical and psychological comfort within the terms of the preceding and following conditions

b Concerning the Child

1 To guard against any diminution of oxygen supply
2 To ensure the minimal degree of central depression due to the anaesthetic agents

It is only with such an approach in mind with its object of ensuring the greatest safety for mother and child that a discussion on obstetric anaesthesia can be presented. For convenience methods of general anaesthesia will here be reviewed first followed by an account of regional techniques the chapter will conclude with a discussion of the serious problem of maternal vomiting

1 General Anaesthesia

1 INHALATIONAL AGENTS

a Ether

Since the eclipse of chloroform, ether has been the most honoured

which an airway may be maintained, and being not as liable as an oro-pharyngeal airway to provoke retching or laryngeal spasm

A manoeuvre which is mentioned only to be condemned, is that of giving carbon dioxide—or of allowing rebreathing in the absence of a functioning absorber—in order to facilitate the rapidity of ether induction In the hands of a competent anaesthetist the time gained by the use of such a method is probably insignificant in respect to foetal depression under other circumstances the ill-effects of the gas on a foetus already in distress would probably be considerable

In domiciliary practice ether will almost exclusively be given by the open-drop method. The absence of a supply of pure oxygen increases considerably the prospective danger of moderately deep anaesthesia However most instrumental deliveries in the home are outlet forceps and for these anaesthesia need be only very light and of short duration—indeed ether analgesia is probably a better connotation It is likely that the latter fact plus the greater caution stimulated by the absence of facilities for resuscitation contributed in good measure to the relatively low incidence of maternal mortality in domiciliary practice which was described by Parker [1]

Elective Caesarean section can provide one of the greatest challenges to the art of the obstetric anaesthetist In the emergency case if the mother objects to the incidents of induction or her recovery is marred by vomiting or a cough, if the operating conditions are not entirely to the liking of the obstetrician or if there is noticeable neonatal depression the anaesthetist can by blunting his insight somewhat persuade himself that elegance was sacrificed to expediency or that much of the distress was due to obstetric difficulties In the case of an elective Caesarean section the anaesthetist must accept total responsibility for any pre- or post-operative distress not of immediate surgical origin suffered by the patient and for any depression of the neonate at delivery

The common indications for elective section are disproportion severe or increasingly severe toxaemia maternal diabetes placenta praevia and breech presentation in an elderly primipara Should placental insufficiency be known or be expected to exist under any of these circumstances the anaesthetist will plan his scheme of drug and oxygen administration accordingly If difficult operative conditions are likely to increase the time between incision and delivery—such conditions as for example the presence of myomata or dense scar tissue—the anaesthetist will have been forewarned of this by the obstetrician There can be no excuse for failure

When a patient arrives in the theatre for an elective Caesarean section

(atropine gr $\frac{1}{100}$ or scopolamine gr $\frac{1}{150}$) intramuscularly at least 5 minutes or intravenously at least 2 minutes before induction of anaesthesia

For delivery in hospital, an anaesthetic machine should be available, with a closed circuit attachment for the use of the accomplished anaesthetist

Anaesthesia should be induced with nitrous oxide or if soda-lime is not in use Trilene It is claimed that anaesthesia can be surreptitiously induced by way *of the mask which the mother has been applying for her inhalational* analgesia This implies that she has been receiving nitrous oxide/oxygen from an anaesthetic machine or that the anaesthetist can induce anaesthesia by placing a finger over the air-inlet of a nitrous oxide/air apparatus The former condition is likely to be of infrequent occurrence, and the latter manoeuvre is strongly to be deprecated, as it must lead to anoxia A total flow-rate of 10-12 litres should be used, in the proportion of 80 20 nitrous oxide to oxygen, in a semi-closed system when a closed-circuit is in use the total flow may be kept down to 4 litres or less *using a 50 50 mixture Ether or Trilene* followed by ether is introduced gradually into the mixture of inhaled gases with even more than the usual care to avoid straining and breath-holding Anaesthesia should be kept to the lightest plane compatible with satisfactory operating conditions In the case of forceps delivery the patient should if possible be placed in the lithotomy position catheterized and towelled before induction, because of the cumulative effect on the foetus of protracted ether anaesthesia For an outlet forceps delivery the ether should be discontinued as soon as episiotomy has been performed to be recommenced after complete delivery of the infant In cases in which some difficulty is expected ether administration should be continued until the largest diameter of the head has been delivered For Caesarean section skin preparation catheterization and towelling should precede induction and the ether flow should be cut off just as the surgeon prepares to incise the uterus

The question of the use of an oro-pharyngeal airway remains a vexed one It is the author s opinion that such an aid should not be invoked until after delivery when anaesthesia can be deepened if it is so desired, unless as in the case of a short-necked or large-tongued patient the difficulties of maintaining an unembarrassed natural airway prove too great In the ordinary course of events anaesthesia before delivery should be so light that pharyngeal stimulation with an airway would be likely to provoke reflex activity in a high proportion of patients Certainly this condition should appertain at the time of delivery A naso-pharyngeal tube might be found to offer some compromise increasing the ease with

(3) Significantly less post-operative vomiting than with ether
(4) Early relaxation of jaw and pharyngeal musculature permitting earlier insertion of an airway should this be required.

The disadvantages are

(1) Maternal respiratory depression necessitates using the technique of assisted respiration
(2) An appreciable incidence of neonatal depression
(3) Difficulty of producing full uterine relaxation without approaching levels of concentration which might prove dangerous to the mother
(4) Virtually necessitates the use of a closed-circuit apparatus
(5) Danger of cardiac arrest in the presence of circulating pitressin
(6) Incompatability with adrenaline—important if the perineum has previously been infiltrated with a local analgesia
(7) Hazards of explosion and fire

When cyclopropane is used as the main agent for induction and maintenance of anaesthesia it is customary and wise to use nitrous oxide as a vehicle for the cyclopropane Induction is carried out with cyclopropane nitrous oxide and oxygen at flow-rates of about 750 ml 1,500 ml and 1 500 ml. per minute respectively by means of a closed-circuit apparatus and using assisted respiration (this method is of course precluded if Trilene has been used extensively for analgesia) As soon as a light and stable depth of anaesthesia has been reached the flow-rates should be re-adjusted to approximately 300 ml. 1 000 ml 1 000 ml per minute cyclopropane nitrous oxide oxygen The same indications for stopping and recommencing the administration of cyclopropane and nitrous oxide at the time of delivery should be used as were described previously for ether However the speed of recovery from cyclopropane is comparatively greater and if it is anticipated that the actual process of delivery is likely to be prolonged, it is advisable to reduce the flow of anaesthetic gases rather more slowly Cyclopropane will provide reasonably satisfactory working conditions for most forceps deliveries If the tone of the uterus or contraction of the pelvic floor muscles, cause considerable embarrassment to the obstetrician then there must be no hesitation in adding a small amount of ether to the mixture should increasing the cyclopropane flow to about 700 ml per minute not have proved helpful Under the circumstances postulated, the neonate would face far less danger from the ether than from the trauma of an unnecessarily difficult delivery Furthermore saving the mother from a degree of traumatic shock and local tissue damage is obviously of greater merit than is avoiding the prospect of increased post-operative vomiting

she is alert possibly apprehensive, and has not been subject to the long and probably wearying ordeal of labour which makes induction in an emergency section so much simpler If she is indeed apprehensive, then the anaesthetist s record will already have become slightly tarnished. If nitrous oxide/ether is the chosen method of anaesthesia then in an unsedated patient it is likely that induction will be an unpleasant memory for mother and anaesthetist. In these patients anaesthesia will have to be fairly deep to provide ideal operative conditions and under such circumstances neonatal depression is more likely to result if ether is used than if some form of balanced anaesthesia is employed. Following operation if ether has been used at least one-third of patients are likely to vomit

All patients should receive some form of sedation on the evening *before* the day of operation Preferentially a barbiturate with or without promethazine should be given The sedative—given at 8 or 9 p m — can be discounted in assessing the total of depressant drugs likely to affect the foetus at the time of delivery It is preferable and, if ether is to be used, very desirable that the mother should receive pre-operative sedation If morphia (gr $\frac{1}{6}$-$\frac{1}{4}$ intramuscularly about 60 minutes before operation) is prescribed, then levallorphan (1 0 mg) should be given either at the same time or injected intravenously at least 10 minutes before the start of anaesthesia Promethazine 25 mg intramuscularly given 45-60 minutes preoperatively might well become the drug of choice in this context

b Cyclopropane

At the time of writing cyclopropane holds an important place in the scheme of anaesthesia for hospital delivery Owing to lack of suitable apparatus it is little used in domiciliary practice Possibly the widespread introduction of an easily portable machine—equipped with sparklet cylinders of cyclopropane—such as Hingson s' Western Reserve Midget, might spur an increase in the popularity of the agent in obstetric work in the home However considerations of the attendant dangers and the cost of cyclopropane anaesthesia are likely to weigh in favour of more recently introduced methods

The advantages offered by cyclopropane in hospital practice are

(1) A smooth and rapid induction associated with this factor a light plane of anaesthesia can be maintained with greater ease than is the case with ether
(2) An ease in rapid manipulation of the depth of anaesthesia

and hypercarbia of foetal distress However this effect is unlikely to have been of significance in the production of a similar result observed by them in their series of elective Caesarean sections

Whatever the mode of action of cyclopropane in leading to neonatal depression, it is apparent that considerable effort must be made to reduce to a minimum the quantity of the drug administered before delivery One method of doing this is by inducing anaesthesia with thiopentone—a drug which will be discussed later It is also a sound practice to hyperventilate the patient with a high oxygen flow keeping the expiratory valve partially opened, just before delivery

The use of cyclopropane within about one hour of the most recent administration of pitressin constitutes an inexcusable risk for the patient Similarly of course the latter drug should not be used during or shortly after operation conducted under cyclopropane anaesthesia The high incidence of cardiac irregularities with possible fatal outcome when this combination of drugs is used is well enough documented[4] to need no emphasis here The free use of cyclopropane in the presence of circulating Pitocin has generally been sanctioned on the grounds that the latter drug of synthetic origin contains no pressor agent However there is some reason to doubt the accuracy of this view[5] Lesser and Eason[6] have reported one case of fatal cardiac arrest seemingly caused by a combined action of cyclopropane and Pitocin It is probably wise to ensure that a patient is never subjected to the influence of Pitocin and of cyclopropane simultaneously

c Other inhalational agents

Aside from its occasional employment as an aid to induction of ether anaesthesia it is not advisable to use Trilene for operative obstetrics Trilene anaesthesia usually entails a long period of induction though it is much less frequently associated with a tumultuous second-stage than is ether Excretion of the drug is an equally lengthy process and hence neonatal depression is a highly probable consequence if this anaesthetic is used.

Almost the oldest inhalational agent can usefully be considered in company with the newest Anaesthesia with both chloroform and Fluothane (Halothane) is characterized by rapidity of induction the production of marked uterine relaxation and a tendency to cardiac irregularities with possible syncope Owing probably to the fact that it was introduced within a more enlightened era devoted to precise measurement Fluothane is administered almost exclusively with the aid of standardized equipment Chloroform is still given by the open-

Cyclopropane can be used for the induction and maintenance of anaesthesia for emergency Caesarean section For this operation the flow-rates of cyclopropane nitrous oxide and oxygen should be the same as those advised for forceps delivery As in the case of the latter operation there will be less likelihood of neonatal depression if skin preparation catheterization and towelling precede induction Except in patients who have undergone exhausting labours or in whom multiparity has led to a considerable laxity of the abdominal wall the operative conditions under cyclopropane anaesthesia are likely to fall short of ideal This is particularly so if the obstetrician s technique includes firm packing of the intestines away from the fundus of the uterus and into the sub-diaphragmatic region These conditions are even more liable to be met with in an elective Caesarean section and may be circumvented by giving a small dose of a non-depolarizing relaxant—preferably d-tubo-curarine about 10-15 mg —at the time of the initial skin incision The question of intubation will be discussed later in this chapter If delivery is made unduly difficult by contraction of the uterine muscle and the latter is not responsive to an increase of cyclopropane within the margins of safety then the addition of ether is indicated

Results obtained in a recent study by Apgar[3] suggested that cyclopropane given as the sole anaesthetic agent for Caesarean section and for premature vaginal vertex delivery occasions greater risk of neonatal depression than does spinal analgesia for such cases There was no significant difference in regard to neonatal mortality It is likely that part of the difference in morbidity is due to placental transmission of a depressive agent though no significant correlation was found between the degree of neonatal depression and the concentration of anaesthetic present in the umbilical vein in Apgar s series A further factor which could be of contributory significance is the tendency of cyclopropane to cause a local arterio-venous shunting effect It is possible that this phenomenon might tend to cause a partial by-passing of the placental site by arterialized blood and that this in association with a strong tendency to maternal respiratory depression even under light cyclopropane anaesthesia might lead to neonatal depression due directly to oxygen-lack However Apgar and her co-workers failed to find any significant difference in terms of the oxygen saturations and carbon dioxide tensions of umbilical vein blood between infants delivered under regional block and those subject to cyclopropane These same workers present the interesting postulate that the relatively unsatisfactory state of neonates following cyclopropane anaesthesia might be related to the invidious effects of the drug on the foetal myocardium in the presence of the anoxia

not increase the likelihood of producing neonatal depression due to the single injection of thiopentone The likelihood is indeed, probably diminished

(3) Relative freedom from unpleasant post-operative sequelae

Associated disadvantages are

(1) It is a deadly weapon in the hands of the unwary or the inexperienced.

(2) Should vomiting occur, it is of more serious significance owing to coincidental decrease in the efficiency of the laryngeal reflex

(3) Increased danger of laryngeal spasm and, reputedly bronchospasm, under light thiopentone anaesthesia

Because of the rapidity with which maternal blood concentrations of thiopentone are mirrored in the foetus administration of the drug before delivery should be confined to the initial dose Depending upon the weight and general condition of the mother about 150-250 mg of thiopentone may be given for induction with an absolute maximum of 300 mg For forceps delivery maintenance of anaesthesia may be based upon nitrous oxide—80 20 nitrous oxide oxygen for 3-4 minutes followed by a 50 50 mixture—or cyclopropane—300 1 000 1 000 cyclopropane nitrous oxide oxygen. The former technique is to be preferred, as the use of cyclopropane will still entail the disadvantages previously listed, despite the decrease in total dosage Either of these methods should prove satisfactory for most forceps deliveries If there is a demand for increased uterine or pelvic floor relaxation cyclopropane or a trace of ether may be added. For emergency Caesarean section the routine injection of 10-15 mg d-tubo-curarine just before the skin is incised will be found to add to the efficiency of a balanced technique and in other respects the scheme just described for forceps delivery should be used If the patient is particularly alert as in the case of elective Caesarean section it will usually be found necessary to employ the cyclopropane technique in order to achieve good operating conditions unless full relaxation together with intubation is substituted.

Premedication with atropine must be part of any scheme of thiopentone anaesthesia. If thiopentone is used for induction it is not necessary to place the patient in lithotomy or to prepare the abdomen before the patient is anaesthetized Indeed it is preferable not to permit these preparations whilst the patient is awake as the possibility of neonatal depression is decreased by prolonging the induction-delivery interval This factor assumes even greater importance in the anaesthetic management of that irritating class of cases E U A Caesarean Section The object of the

drop method. Both drugs must be preceded by atropine premedication. The dangers to heart and liver offered by chloroform administration are so well known that an anaesthetist who employs the drug must be *prepared to accept an increased degree of responsibility for the welfare* of his patient Chloroform anaesthesia in obstetrics is not advisable unless the administrator has had very considerable experience with the drug One of its main advantages has been the absence of an associated fire or explosion hazard. This is no longer a pressing indication, as such hazards can be circumvented by removing the source of ignition or by using intravenous anaesthesia.

Because of the apparatus involved in its use Fluothane is unlikely to become popular in domiciliary practice Too short a period has passed since its introduction to assess the place it is likely to find in hospital practice However an initial survey seems to indicate that it offers few advantages and some disadvantages when compared with other techniques Use of the drug confers an easy and rapid induction comparative freedom from vomiting and apparently no striking degree of maternal depression There is however an ever-present danger of serious cardiovascular disturbance and the uterine flaccidity produced by the drug is apparently so marked, that administration must cease or at least be drastically curtailed before the end of the operation in order to guard against its causing severe post-partum haemorrhage [7, 8] On the other hand, it must in fairness be added that Brown and Woods [9] in alluding to sixteen Caesarean sections anaesthetized with Fluothane have nothing but praise for the drug and say that in their experience uterine contraction and retraction are not affected by it.

Finally as the rate of production of cardiac arrhythmias is known to increase greatly when adrenaline is given in the presence of chloroform (though not apparently in the presence of Fluothane[10]) it is probably correct to surmise that this anaesthetic should not be administered if the patient has recently been given pitressin

ii. INTRAVENOUS AGENTS

a Thiopentone

The poor analgesic property of thiopentone when compared with its depressant central action, precludes its use as the sole anaesthetic for any but the most rapid of operative deliveries

The advantages of thiopentone as an induction agent are

(1) Rapidity of action and freedom from subjective unpleasantness

(2) Prolongation of the induction—parturition interval probably does

in an attempt to indicate that when the method is successfully employed, the patient, although rendered free from pain apprehension and general discomfort is still sensibly aware of her environment

In general the method involves the use of a phenothiazine derivative a narcotic and a narcotic antagonist [12] Chlorpromazine and promethazine have been the phenothiazine derivatives most commonly used in this country Their respective merits in obstetrics have already been discussed (in Chapter III) and further reference will be made only to promethazine Pethidine is the sole narcotic of choice—the employment of morphia has not been described, and that of alphaprodine is limited to the United States—and, whilst the choice of antagonist lies between levallorphan nalorphine and amiphenazole discussion will be limited to levallorphan, for reasons outlined in Chapter III

As so far evolved, the recommended method is as follows

At least 10-15 minutes before the start of surgery with the patient lying in her position of greatest ease a mixture of 100-150 mg pethidine 1 0-1 5 mg levallorphan and 25-50 mg promethazine made up with water to a dilution of 10 mg pethidine per 1 ml solution is slowly injected intravenously over a period of [illegible]-3 minutes The absolute quantities of pethidine and promethazine used (the levallorphan/pethidine ratio must always be 1 100) will depend, as always upon the weight and general condition of the patient, and upon the amplitude of her response to the initial few millilitres

In the light of our present knowledge although it is felt with reasonable certainty that significant hypotension will not occur it is strongly advised that frequent blood pressure readings be recorded during the course of hypoaesthesia

After the necessary lapse of time during which the subjective response to each contraction will be seen to diminish (there is no contraindication to allowing nitrous oxide or Trilene analgesia if already in use to continue for the first few minutes after injection) the patient is placed into the lithotomy position having been forewarned of this manoeuvre Each major step in the preparation and the process of delivery should be preceded by advising the patient to expect a fresh series of stimuli but ones which will be neither painful nor unpleasant

It has been found necessary on occasion to provide extra analgesic cover by injecting the line of the proposed episiotomy with local anaesthetic This is possibly a reflection of an inadequate interval between induction of hypoaesthesia and the start of surgery There is some evidence that the phenothiazine element of the mixture helps to provide a degree of relaxation of the pelvic floor [14, 15] However should this struc-

examination in these patients is usually to decide whether or not vaginal haemorrhage is due to a separating placenta praevia. Epidural and spinal analgesia are obviously contraindicated under such circumstances and a thiopentone induction followed by maintenance with nitrous oxide and oxygen during the period of examination is the scheme of general anaesthesia least likely to lead to a dangerous depression of the foetus

Naturally there is a certain equation involved in the likelihood of the production of neonatal depression following thiopentone-induced anaesthesia Although the significance of the thiopentone decreases with the passage of time that of the agents used for maintenance increases If nitrous oxide is the sole other anaesthetic time is probably of little importance provided anaesthesia can satisfactorily be maintained. If however cyclopropane is employed, delay of delivery for longer than about 20 minutes after induction of anaesthesia is likely to lead to neonatal depression caused mainly by the inhalational anaesthetic The optimum time of delivery under such a scheme of anaesthesia is probably 5-10 minutes after the start of the thiopentone injection

Use of an oro-pharyngeal airway and failure to pay careful attention to the maintenance of a clear natural airway, are the main causes of laryngo-spasm and vomiting noted above as disadvantages of thiopentone in obstetric anaesthesia Adequate premedication with atropine care in holding the chin and avoidance of an oro-pharyngeal airway should virtually eliminate the possibility of laryngeal spasm

A further method of providing analgesia in association with thiopentone induction—especially for elective Caesarean section—is the use of the technique of intermittent intravenous injections of pethidine as employed in balanced anaesthesia for general surgery Bingham[11] has described the use of such a technique in a series of 359 Caesarean sections and the excellence of his results are strongly in its favour Neonatal depression consequent upon the pethidine should be avoided by giving 1 mg levallorphan before the start of anaesthesia or by the use of a pethidine/levallorphan mixture This technique offers considerable advantage in cases of trial of forceps when ultimate delivery—possibly by Caesarean section—is likely to be effected only after prolonged anaesthesia

b Phenothiazine derivatives

A recent approach to the problems of obstetric anaesthesia involves the use of phenothiazine derivatives The method does not lead to the production of anaesthesia but to a condition which has been termed ataralgesia [12] or hypoaesthesia [13] These terms have been introduced

taken to indicate not only blocking of the branches of both pudendal nerves, but to include adequate local infiltration of the perineum and labia.

Used as the sole method of relieving the pain of certain types of forceps delivery pudendal block is probably attended by the least danger to mother and child. It is generally accepted[1] that only about 60 per cent of forceps deliveries can be satisfactorily performed under local analgesia. Unreinforced pudendal block does not offer sufficiently extensive analgesia or adequate uterine relaxation for operations involving considerable rotation of the head, or for those in which the head is not at the outlet. Recently Scott and Gadd[14] have described the use of pudendal block supplemented in certain cases with pethidine and chlorpromazine for extending the application of local analgesic technique to about 90 per cent of all forceps deliveries Their method is based on the employment of Kelland's forceps As indicated in the previous section full application of hypoaesthesia, without pudendal block, might well produce equally satisfactory results However as Parker[1] points out for those forceps deliveries requiring little manipulation pudendal block must be placed very high on the list of methods of choice Within this category of patients there are virtually no contraindications to pudendal block, and the only noteworthy complications are toxic effects due to overdosage of or sensitivity to the analgesic (which should be an extremely rare occurrence if an accepted technique is closely followed) and the production of a vulval haematoma.

ii. Spinal Analgesia

The use of spinal and extra-dural block methods of analgesia must of course be confined to hospital practice

Before starting upon any discussion of the application of spinal and extra-dural analgesia to operative delivery it is necessary to stipulate a number of factors which absolutely contraindicate the use of these methods

i relative maternal hypotension
ii. maternal anaemia
iii poor general condition of the mother
iv absence of an immediately available source of pure oxygen
v absence of means of resuscitation—including a tilting table

The majority opinion in Britain is against the use of spinal analgesia for any surgery including obstetric To an appreciable extent this bias is derived from the attitude of the general public Patients in this country

ture or the height of uterine tone, obstruct the obstetrician unduly the anaesthetist can offer increased aid by administering 75 25 nitrous oxide oxygen or Trilene or a short spell of cyclopropane Resort to these latter aids should rarely be needed

Atropine premedication is not a necessary preliminary to hypoaesthesia. An oro-pharyngeal airway is not indicated and there is very little reason why vomiting should occur before during or after operation—indeed, the method can be said to preclude nausea and vomiting Oxygenation is adequate throughout but in cases of foetal distress (see below) increased oxygen should be given to the mother

At present hypoaesthesia is recommended for general use—in both domiciliary and hospital practice—only in cases of simple forceps delivery not involving more manipulation than slight rotation of a malpositioned head and in the absence of foetal depression The impression is that it will prove to be safely and satisfactorily applicable to all cases of forceps delivery but investigation of this must for the time being be confined to special hospitals with research facilities The place of the method in Caesarean section is as yet entirely without significant investigation

c *Relaxant drugs*

The choice of relaxant drugs is limited mainly by the factor of possible placental transmission of the agent and this has been discussed in Chapter II It is evident that d-tubocurarine is to be preferred to Flaxedil if a non-depolarizing drug is to be used Recent observations recorded by Hodges[16] suggest that if suxamethonium is utilized the possibility of the conversion of its action from depolarizing to non-depolarizing in the presence of Pitocin must be borne in mind

2 Regional Techniques

For a discussion of the drugs used in regional analgesia the reader is referred to Chapter III

1 Pudendal Block

For obvious reasons of convenience the administration of a pudendal block is more properly within the province of the obstetrician than of the anaesthetist The anaesthetist should however be competent to perform such a block and of course be well acquainted with the anatomical considerations underlying the technique There are many published accounts of the general procedure[17, 18] and to these the reader is referred for instruction It is to be noted that the term pudendal block is tacitly

significance in this regard is the time when the patient is returned from the lithotomy position at the end of operation

For Caesarean section the injection should be made at the same site, and with the same precautions Analgesia is required to extend to the level of T8 and the requisite dosage is 0 6–0 8 ml of $\frac{1}{100}$ nupercaine in 6 per cent glucose or 6–8 mg pontocaine in 2 0–2 5 ml of 10 per cent glucose

It is a common prophylactic practice to add a vaso-pressor such as 5 0 mg methedrine to the local analgesic used for the skin weal prior to spinal puncture The possible effect of this on the foetus which is already distressed has been noted in Chapter II If the practice is not followed there is need for even greater vigilance regarding blood-pressure changes after the spinal has been given Forthman and Adriani [21] in a series of 391 Caesarean sections carried out under spinal analgesia noted a degree of hypotension in 82 per cent. Only 20 of their patients were given ephedrine intramuscularly prior to the spinal and 2 of these developed hypotension. The average systolic blood-pressure fall for the series was 30 mm. Hg These findings alone in the hands of acknowledged leaders in the field of anaesthesia would seem to vitiate against advising the use of spinal analgesia in the presence of any degree of foetal distress Holmes[22] has pointed out that the effects of peripheral vaso-dilatation attendant upon any spinal block rising above the level of L2 are likely noticeably to be increased by the partial occlusion of the inferior vena cava by the uterus when the patient is supine The consequent sudden decrease in venous return to the heart is a likely cause of acute circulatory collapse in obstetric cases The immediate treatment of such collapse or of any severe degree of hypotension must be to administer 100 per cent oxygen and to elevate the legs of the patient sufficiently to give an adequate auto-transfusion of blood. Following these measures a vaso-pressor should be given intravenously It is unwise immediately to tilt the patient into a Trendelenberg position lest the analgesic drug travel even further cephalad and also because the increased gravitational pressure of the uterus on the diaphragm is likely to add to the dangerous state of the mother Only when it is possible to institute the satisfactory administration of oxygen under intermittent positive pressure (preferably after the patient has been anaesthetized and intubated) should the table be tilted head-down

As has been pointed out in Chapter I during pregnancy there is an increasing dependence upon the thoracic component of respiratory activity When Caesarean section is performed under spinal analgesia the lower 4 or 5 intercostal muscles are paralysed, with resultant respira-

apparently prefer to be asleep during their operations evidencing little curiosity about what is going on in the theatre The opinions of surgeons and anaesthetists is based upon a number of points

the undoubted fear of ruinous (in terms of self-confidence reputation and money) legal proceedings which seemingly are an inevitable consequence of any but the most minor complications of spinal analgesia

that the possible complications of regional analgesia outweigh any advantage offered

somewhat paradoxically, the feeling that to give a spinal is a confession of failure that the standard of British anaesthesia is now so high that the use of such a blunderbuss technique in place of 'balanced anaesthesia is a retrogressive step

The latter argument is undoubtedly a form of overswing following the introduction of the newer drugs primarily the relaxants and there is evidence that it is now being corrected Unfortunately the attitude carries a very real danger in that it tends to cloud the important fact that certainly as great attention must be paid to the conduction of spinal analgesia as is paid to the most delicately balanced general anaesthetic That there is a place for spinal analgesia in general surgery is undoubted whether or not the indications in obstetric practice are of significant dimensions is a more open question but truly the technique and safeguards must be understood by all undertaking obstetric anaesthesia

For a forceps delivery a low spinal is given with the objective of obtaining analgesia up to the level of T10 The agents in general use are $\frac{1}{200}$ nupercaine in 6 per cent glucose—the dosage being 0 4–0 6 ml.—and pontocaine 4–6 mg made up to 2 0–2 5 ml in 10 per cent glucose The injection is made in the third or fourth lumbar interspace using a fine-pointed 22-guage spinal needle the patient should be in the lateral position and the table should be tilted 15–20 degrees head-up As soon as the injection has been completed the patient should be placed flat on her back and one minute later the table is returned to the horizontal.[0] There is an appreciable number of departments in which the patient is made to sit whilst the spinal is being given This appears to increase the discomfort and distress of the mother and in the case of outlet forceps deliveries adds to the possible dangers to the infant Under no circumstances should the analgesic drug be injected whilst the uterus is in contraction as the associated turbulence effects within the cerebro-spinal fluid are likely to lead to undue and possibly disastrous spread of the drug Blood-pressure readings must be taken before the block is instituted and at frequent intervals during the subsequent 10–15 minutes Of special

Massey Dawkins[25] advises the use of the twelfth thoracic interspace Using 1¾ per cent Xylocaine with 1 250 000 adrenaline he injects ---24 ml and thereby aims to achieve analgesia extending from T8 to T12 inclusively Foldes[26] advocates the use of a catheter for though the operation is usually completed (in Britain) within the effective period of the first dose the catheter-method increases the safeguard against inadvertent puncture of the dura. Foldes using 3 per cent 2-chloroprocaine with added adrenaline injects an initial dose (including the test dose) of about 24 ml of analgesic drug utilizing the third or fourth lumbar interspace He also makes the point that the patient should be tilted 5-10 degrees foot-down during the period of drug-fixation as for some reason these patients appear to retain supra-pubic sensitivity if the injection is made whilst they are in the horizontal position In each of these methods the usual test dose is advocated as a preliminary

Massey Dawkins [5] on the basis of his considerable experience with the extra-dural technique considers that

in 1 0 per cent of cases it is impossible to initiate a block because of local anatomical difficulties
in 1 5 per cent the method is a failure,
in 1 0 per cent significant hypotension develops

McKay [7] in the course of an account of 699 obstetric cases conducted under continuous epidural analgesia in Toronto General Hospital comments on the fact that the series included 76 Caesarean sections Almost all of these patients needed some form of general anaesthesia during part of the course of their operation This feature is an important and disturbing one Manipulation within the upper abdominal region—especially rather vigorous packing of the coils of small intestine away from the uterus—and in the same genre the slight Trendelenberg tilt requested by some obstetricians frequently provoke sharp complaints from the mother Objectively it is not uncommon for hiccoughing retching or vomiting to occur and, apart from the direct danger offered to the mother such episodes are liable to interfere with the course of the operation Under these circumstances the intravenous injection to the mother of 25 mg promethazine with or without 25 mg pethidine plus 0 25 mg levallorphan can often restore the equanimity of both mother and surgeon

Epidural block appears not to lead to the increase in uterine tone which is seen in association with spinal analgesia The range and gravity of dangers to the foetus are certainly far less from epidural analgesia than from a spinal In cases of elective Caesarean section in which it is impera-

tory embarrassment which is not infrequently very well marked. Such a state of affairs will persist until extraction of the foetus permits a return to full-functioning of the diaphragm, and until that time oxygen must be given to the patient from the moment the spinal begins to take effect.[23]

Makepeace[24] in a recent review of 1 840 deliveries conducted under spinal analgesia, noted that 18 per cent of the patients complained of headache—of varying severity—post-operatively. Of the patients undergoing Caesarean section 10·8 per cent demonstrated this reaction, as did 20·1 per cent of those delivered vaginally. It is of interest to note in this context that in the series reported by Forthman and Adriani,[21] and previously referred to, 54 per cent of the patients receiving spinal analgesia exhibited post-operative hypertension, compared with 2·5 per cent in another group who were given a general anaesthetic for delivery, the average rise in systolic blood-pressure being 20 mm. Hg.

Characteristically an increasing intensity of uterine tone follows the administration of spinal analgesia. This effect undoubtedly plays an important part in reducing the flow of blood through the placental site. Once a spinal has been given no time must be lost in delivering the baby or death in utero can result from primary anoxia. Because of this increased tonicity spinal analgesia is contraindicated for forceps delivery involving any but the least amount of intrauterine manipulation. For a like reason spinal analgesia is contraindicated for those Caesarean sections in which operation is likely to be prolonged due, for example, to adhesions or in which the lower uterine segment is likely to be thin, as in obstructed labour due to shoulder presentation.

iii. Epidural Block

The employment of caudal or lumbar epidural block for the emergency operation of forceps delivery is not advocated. The time involved, and the relatively high failure rate, diminish the appeal of a method which, on the positive side, offers little or no danger of drug intoxication to the foetus and, when successful, ensures almost complete freedom from discomfort for the mother. If either form of epidural analgesia is contemplated in a particular patient—as for instance one with severe heart disease—it is advisable to initiate the block early in labour, utilizing a polyvinyl catheter. By so doing a satisfactory control of the level of analgesia is obtained, and the full co-operation and confidence of the patient is better assured.

The place of epidural analgesia in the management of Caesarean section is more firmly based. There is a small range in the choice of techniques

or worse to other residents who have never received and who are not receiving training in any other aspect of the speciality

Of these factors the last is probably the most important It will be discussed later in this book.

It is traditionally held that the time normally taken by the stomach to empty is increased in labour This is said to be somewhat akin to the delayed gastric emptying following severe trauma and to be due possibly to a like cause An attempt has been made[30] to demonstrate that, in the first stage of labour the range of gastric emptying times is comparable with that accepted as normal in the non-pregnant This finding applied only to fluid contents However in cases of prolonged and exhausting labour there can be no doubt that there is considerable retention of stomach contents and on the whole it is most advisable to regard the obstetric patient as presenting with a significant volume of intragastric material unless there is extremely strong evidence to the contrary In addition it has been observed repeatedly since Mendelson[31] first drew attention to the syndrome that the aspiration of a very small quantity of highly acid gastric contents can rapidly lead to serious and even fatal consequences In this connection the suggestion made by Dinnick,[28] of giving antacid tablets to women in labour—especially to those with a history of dyspepsia—is worthy of pursuance

When it is known that a patient who is not in labour has eaten a substantial meal or drunk a considerable amount of fluid within a period of four to six hours prior to the proposed time of operation common sense urges that steps be taken to relieve her stomach of its contents before anaesthesia is induced. The comparable period in the case of a patient who last ate after commencement of her labour is approximately eight to ten hours It has been argued that under these conditions the use of regional analgesia obviates the necessity of emptying the stomach Regarding this it must first be stated that the aspiration of vomited or regurgitated material is not necessarily precluded by the use of conduction analgesia Klein,[3*] in his account of maternal mortality in King s County New York, refers to the deaths of eleven mothers in one year following the inhalation of vomited gastric contents during the course of delivery under spinal analgesia Indeed Stearns and Frederickson[33] on the basis of their considerable experience with regional techniques remark that there is probably no more certain way to produce vomiting than by the administration of spinal anesthesia for Caesarean section It is likely that the chance of the occurrence of such an accident is less under epidural analgesia than under spinal but it still exists and must therefore still be anticipated

tive to keep to the minimum the amount of depressant drug reaching the foetus—as in severe toxaemia of pregnancy prematurity or pronounced post-maturity—and in cases of emergency Caesarean section, where haemorrhage is not a complication and the start of operation not of the utmost urgency, epidural analgesia must be given high priority in the choice of methods available to the competent anaesthetist

Vomiting

The number of deaths in England and Wales resulting from the inhalation of regurgitated or vomited material during the course of anaesthesia for operative delivery has been variously estimated as being from fifteen[*8] to twenty[1] annually during the past few years The precise number is of little significance to the present theme except in as much as it will help to reflect the degree of success of a national effort to eradicate this tragedy *That the problem is still with us and is not confined to this* country has been indicated most recently by an account of 3 maternal deaths following the administration of general anaesthesia for delivery which occurred in one hospital during a period of 17 months[29] Related to the number of deliveries each year or even to the number of obstetric anaesthetics which it is estimated are given annually the number of deaths might appear to be small. However each one must be stigmatized as having been a completely avoidable tragedy and anaesthetists bear the full responsibility of ensuring that the annual rate is rapidly reduced. It must also be recognized that maternal death is the end-point of a process and that for every death recorded there must be a considerable number of cases in which the final catastrophe was avoided, but maternal morbidity and possibly perinatal death or irreparable damage resulted.

The notorious position held in the realm of obstetric anaesthesia by the aspiration of foreign material derives from the following factors most of which are interrelated

(1) the very high proportion of emergency operations involving (*a*) the need for haste (*b*) a relatively unprepared patient
(2) the tendency to retention of gastric contents especially in the event of prolonged labour
(3) the raised intra-abdominal pressure consequent upon the size of the pregnant uterus
(4) attempts to maintain light anaesthesia without minimizing pharyngeal stimulation
(5) delegation of responsibility in this field to very junior anaesthetists

a recent report[35] of a wide application of the technique suggests that it holds considerable merit.*

Both the passage of a stomach-tube and the injection of apomorphine will, especially in the former case lead to some degree of maternal discomfort—this is an insignificant price to pay for the vast increase in safety It has been claimed that the straining and breath-holding which occurs during the manoeuvre (again notably when a stomach-tube is passed) might lead to increased disruption of the placental site, or at least temporarily to further diminution in foetal oxygenation The fleeting nature of the measure makes it unlikely that these factors will have any significance in terms of perinatal salvage but should they give rise to any real anxiety it would be advisable to employ apomorphine rather than a gastric-tube

However the apparent success of either of these methods must not be taken as indicating that the stomach has been emptied. The only danger which has been averted is that of massive regurgitation or vomiting and considerable though that lightening of the load might be the patient must subsequently be treated with the utmost circumspection In the cases under discussion (i e emergency Caesarean section either before the onset of labour or in the early stages of the first part of labour) the recommendations as outlined previously should be followed Any temporary obstruction to the airway must be avoided for as O Mullane[36] has shown this condition especially in the presence of raised intra-abdominal pressure strongly favours the production of regurgitation A rapid and smooth induction with thiopentone in competent hands is advocated as that least likely to be attended by vomiting or laryngeal spasm The use of an oro-pharyngeal airway is deprecated for reasons previously given If the stature of the patient is such as to suggest that maintenance of an airway will prove difficult intubation must be undertaken Routine intubation is advocated by many authorities [37, 10] There are two methods open to use conscious intubation following careful spraying of the mouth pharynx cords trachea, and carina with a local analgesic and intubation following administration of a relaxant drug The former offers the danger of silent aspiration post-operatively the latter entails a dangerous period of delay between induction of anaesthesia

* In a personal communication Professor Robert T White of the Department of Medicine University of Colorado has reported that the use of apomorphine in seventy five cases has revealed no unpleasant or dangerous side-effects in the mothers and no resultant harm to the infants He and Dr Robert E Dean—who is to read a paper on the subject to the American College of Obstetricians and Gynecologists in October 1958 (later to be published in *Obstetrics and Gynecology*)—have been quite impressed by the technique

It will be found helpful to consider further the specific instances in which the prospect posed might arise Elective Caesarean section may be omitted from the discussion as only under conditions of gross mismanagement is vomiting likely to occur These patients must be treated pre-operatively along the same lines as the general cold surgical patient and if they are diabetic must be given glucose and insulin only by the intravenous route in the traditional manner

The patient who is not in established labour and who presents for an emergency Caesarean section will do so for one of the following reasons

(*a*) vaginal haemorrhage—associated with either placenta praevia or toxaemia of pregnancy
(*b*) prolapsed cord following premature rupture of the membranes
(*c*) apparent foetal distress
(*d*) she was booked for an elective section and has gone into labour prematurely

In each of these situations other than (*d*) spinal analgesia is absolutely and epidural analgesia relatively contraindicated Before general anaesthesia is induced the stomach—should the volume of its contents be suspected of being appreciable—must be relieved of the greater part of its load Two methods are available to effect this manoeuvre (*a*) a large-bore stomach-tube may be passed (a size 10 oesophageal tube is the smallest bore permissible) to act both as a means of siphoning-out the fluid gastric contents and of provoking active vomiting (*b*) apomorphine hydrochloride may be given to stimulate the vomiting-centre Holmes[34] initially advocated that apomorphine should be used in the following manner gr $\frac{1}{20}$ (3 mg) of the drug is dissolved in 10 ml of water and the solution given by slow intravenous injection until nausea and vomiting commence at which time the injection is stopped Holmes comments that from gr $\frac{1}{70}$ to gr $\frac{1}{30}$ with an average of gr $\frac{1}{45}$ (1-2 mg average 1 5 mg) is needed to produce a result and that nausea rapidly subsides as soon as the stomach is emptied a process which he states usually takes about 3 minutes Holmes found no side-effects of note other than a slight increase in sweating and lacrimation and a rise in maternal pulse-rate of about 10-20 beats per minute Atropine sulphate gr $\frac{1}{150}$ (0 4 mg) injected slowly intravenously after the episode of nausea and vomiting has ended tends to offset these mild vagal-stimulant effects of apomorphine There was no apparent consequent neonatal depression Dinnick[28] strongly queries the efficiency and safety of this routine but

might have to be foregone It is in these cases that the attendance of an expert anaesthetist is most desirable—and least often realized If speed is so essential then obviously epidural analgesia is not practicable If the obstetrician is adept at administering a pudendal block then this must be the method of choice In the event of intra-uterine manipulations being necessary pudendal block should still be performed, and will serve to allow the obstetrician to undertake his preliminary manoeuvres whilst the anaesthetist is preparing to cover the extra pain and to diminish uterine tone In such a case light cyclopropane anaesthesia, or ether analgesia is probably all that will be required. Suction apparatus should, as ever be on hand and working

If the obstetrician is not adept at the technique of pudendal block then the patient will require general anaesthesia for a rather longer time She should be placed in a head-up tilt to decrease the chances of silent regurgitation from the oesophagus and induced with a minimal amount of thiopentone or cyclopropane followed only at the request of the obstetrician by ether Succinyl-choline—already drawn up in a syringe—and the implements of intubation must be ready for instant use should laryngeal spasm or vomiting occur

The rather dramatic cases comprising this group are relatively rare being more usually associated with a prolapsed cord (see next chapter) More frequently the patient presents without a history of undue oral intake and the obstetric indication for extreme haste is less marked. If the proposed operation is an outlet forceps (as will be most likely in domiciliary practice) the two methods of choice are pudendal block and hypoaesthesia. Both methods are accompanied by a minimal tendency to vomiting and regurgitation and in both the patient retains a fully-active laryngeal reflex Efficiently performed pudendal block will take 5 minutes being started after the towelling-up preliminaries have been completed hypoaesthesia will become effective 10-15 minutes after completion of the injection which is given before surgical preparation of the patient is begun If further aid is needed during the course of intra-uterine manipulation inhalational analgesia may be administered

The alternatives to the above-suggested régimes are thiopentone cyclopropane low spinal or ether anaesthesia in descending order of merit, and their respective roles in the possible production of vomiting have already been discussed Epidural analgesia would appear to offer no more advantage than does pudendal block in avoiding the dangers of vomiting during forceps delivery and it involves a far more elaborate and time-consuming ritual unless the epidural catheter is already in position

and passage of the endotracheal tube In either case an adequately tested, cuffed endotracheal tube and a reliable laryngoscope are essential. When intubation is the method chosen the patient should preferably be placed about 15-20 degrees into a foot-down position until after the tube has been inserted and the cuff inflated [38] this measure helps to guard against the possibility of regurgitation of oesophageal contents past an incompetently-rendered crico-pharyngeal sphincter [36]

One further point remains to be emphasized Under no circumstances must the business of anaesthesia be started—whatever the method to be employed—until the anaesthetist has within his reach (and preferably lying beside the head of the patient) a length of wide-bore tubing which leads to a suction apparatus As a preliminary this apparatus must be found to be working efficiently and it should be switched on throughout the proceedings To neglect these precautions would be an act of criminal folly

The emergency Caesarean section which is undertaken after labour has been in progress for some time invokes a different range of possible anaesthetic techniques for avoiding the hazards of aspiration If there is good reason to suppose that the volume of gastric contents is considerable then the stomach should be emptied as described above There seems to be no point whatsoever in exposing the mother whether anaesthetized by regional or general techniques to the danger of massive vomiting or regurgitation when prophylaxis is so simple and so devoid of serious danger Again however it must be remembered that gastric and oesophageal evacuation is only a preliminary measure If it is reasonably certain that the volume of gastric contents is not very large but the mother is known to have been taking fluids orally during the previous 8-10 hours and there are no maternal or foetal contraindications to epidural analgesia then this is probably the method of choice for emergency Caesarean section The best alternative is probably a thiopentone induction with or without intubation using either of the methods previously described. If intubation and a full relaxant technique is used a further danger must be appreciated The patient is of necessity kept in a light plane of anaesthesia until the infant is delivered. If she is completely paralyzed at the same time it is not inconceivable that she might inadvertently be allowed to recover consciousness during the course of the operation The moral to be drawn from this supposition is obvious

Proposed forceps delivery of a patient who is likely to have a full stomach involves the anaesthetist in yet a third dilemma Again if there is evidence that a heavy meal has recently been taken gastric emptying should be instituted. However the degree of urgency (referable to the foetus) in forceps deliveries is sometimes such that this initial measure

6. Lesser M. and Eason, C A. (1954) Cardiac arrest under anaesthesia during induction of labour with "Pitocin" drip Brit. med J 2 [illegible]9
7. Mackay L. M. (1957) Clinical evaluation of Fluothane with special reference to a controlled percentage vaporizer Canad. Anaesth Soc J 4 [illegible]35
8. Russell, J T (1958) Halothane and Caesarean section. Correspondence Anaesthesia, 13 [illegible]41
9. Brown, T A. and Woods, M A (1958) Halothane ("Fluothane") in a country hospital. Brit. J Anaesth., 30 333
10. "Fluothane" A report to the Medical Research Council by the Committee on Non-explosive Anaesthetic Agents (1957) Brit med J., 2 479
11. Bingham, W (1957) Balanced anaesthesia for Caesarean section. Anaesthesia, 12, 435.
12. Hayward-Butt, J T (1957) Ataralgesia operations without anaesthesia Lancet 2, 972.
13. Crawford, J S. (1958) Anaesthesia for obstetrics recent advances. Brit. med Bull., 14 34
14. Davies, J L (1955) Use of largactil in obstetrics. Canad. Anaesth. Soc J., 2, 3[illegible]
15. Wertyn, S. P and Marks, R. A (1958) Promethazine meperidine and spinal anesthesia for labor and delivery J Amer med. Ass 167 1918
16. Hodges, R. J H. (1955) Interaction of suxamethonium and oxytocin. Correspondence Brit. med. J., 1 1416.
17. Gate, J M. and Dutton, W A. W (1955) Forceps delivery under local analgesia. Brit. med J., 2, 99.
18. Wilds, P L. (1956) Transvaginal pudendal-nerve block. Obstet and Gynec., 8 385
19. Scott, J S and Gadd, R. L. (1957) Local analgesia and Kielland's forceps. Brit. med. J., 1 971
20. Foldes, F F (1958) Personal communication.
21. Forthman, H. J and Adriani, J (1957) Blood-pressure changes during Caesarean section. Anesth. & Analg 36 (Mar–April) 63
22. Holmes, F (1957) Spinal analgesia and Caesarean section. J Obstet Gynaec Brit. Emp., 64 [illegible]9
23. Macintosh, R. R. (1950) Spinal analgesia for Caesarean section. Correspondence Brit. med. J., 1 1076.
24. Makepeace A. W. (1958) Spinal anesthesia in obstetrics. Obstet and Gynec., 11 438
25. Dawkins, C. J M. (1956) Extra-dural analgesia in obstetrics and gynaecology P stgrad med. J 32, 544.
26. Foldes, F F and Crawford, J S (1958) *Epidural Analgesia in Gynecology and Obstetrics* Paper presented at the Congress of the Scandinavian Society of Anesthesiologists, Gausdal, Norway Sept 1958
27. Mackay L M. (1957) Lumbar epidural anaesthesia for obstetrics at the Toronto General Hospital. Canad. Anaesth Soc J., 4 112
28. Dinnick, O P (1957) In Discussion on anaesthesia for obstetrics an evaluation of general and regional methods. Proc roy Soc Med., 50 547
29. Baker G L. and Hublein, G W (1958) Post-operative aspiration pneumonitis. Amer J Roentgen. L, 80 4[illegible]
30. Crawford, J S (1956) Some aspects of obstetric anaesthesia. Brit J Anaesth. 28 [illegible]01

After all operative deliveries whatever the method of pain-relief utilized, the mother should be treated on the lines adopted for general surgical patients—she should be placed on her side Dinnick[38] has drawn attention to the fact that in Hingson's series 30 per cent of the patients who vomited did so after the birth of the child. Aspiration under such conditions must, of course, be prevented by attention to the general principles of anaesthesia.

It has frequently been suggested[39, 40] that if the patient is to be delivered on a table which cannot be tilted (as for instance in domiciliary practice) general anaesthesia should be induced, and forceps delivery effected, with the patient lying in the lateral position. Whilst this practice would undoubtedly decrease the danger of aspiration of any material which might be vomited or regurgitated, it is considered that the prevention of the initial occurrence is of greater urgency Also institution of the practice appears to be attendant more upon the wishes of the obstetrician than of those of the anaesthetist.

Finally two further matters of prophylaxis must be emphasized. If a mask is used for the administration of either pure oxygen or of an anaesthetic, it must on no account be strapped upon the patient's face. A tightly fitting mask can effectively conceal the presence of regurgitated material in the mouth. It is further to decrease this danger that Parker[1] advises also the use of transparent masks in obstetric anaesthetic practice

Secondly any mother who gives evidence of entering upon a protracted labour should receive her fluid and glucose intake intravenously Significant gastric retention is closely associated with prolonged labour and in such a case the patient should receive nothing orally except frequent refreshing mouth-washes which are to be returned immediately in toto This matter demands the vigilance of both obstetricians and anaesthetists

REFERENCES

1 Parker R. B (1956) Maternal death from aspiration asphyxia. *Brit med J* 2 16

2. Hingson, R. A (1958) 'Western Reserve anesthesia machine oxygen inhalator and resuscitator *J Amer med. Ass* 167 1077

3 Apgar V Holladay D A. James, L. S Prince C. E. and Weisbrot, I M. (1957) Comparison of regional and general anesthesia in obstetrics, with special reference to transmission of cyclopropane across the placenta. *J Amer med Ass* 165 -155

4. Greenhill, J P (195-) *Analgesia and Anesthesia in Obstetrics* 1st ed. Thomas Springfield, Ill.

5 Francis, H. H. and Francis, W J A. (1956) Clinical trial of synthetic oxytocin. *Brit med. J* 1 1136

CHAPTER V

OTHER INDICATIONS FOR ANAESTHESIA

1 Breech Presentation

In one out of approximately thirty labours the breech forms the presenting part. However, this ratio falls to one in sixty if premature deliveries of shorter than 3[illegible] weeks' gestation are excluded.[1] From the point of view of the anaesthetist, breech presentation may be classified roughly as

i. Complete breech presentation
ii. Incomplete breech presentation—implying usually breech with extended legs

In part due to the close alliance of this condition with prematurity and to the mechanics involved in effecting vaginal delivery, there is a high perinatal mortality associated with breech labour—about 10 per cent in primipara, slightly less in multipara.[1] Although some of the contributing factors are outside his province, the anaesthetist has a very important part to play in the attempt to reduce this appalling death-rate.

The methods of breech delivery may be classified as

i. Spontaneous delivery with minimal assistance.
ii. Assisted delivery.
iii. Extraction.

All deliveries are usually carried out with the patient in the lithotomy position.

i. Spontaneous Delivery

In these cases the *obstetrician usually performs an episiotomy under* local infiltration and, correlating his actions with the expulsive efforts of the mother, gently eases the child along its path to complete delivery. If the operation is successful, an anaesthetic will not have been required. However, such success can never be guaranteed, and in many hospitals an anaesthetist is requested to attend all breech deliveries. The fact that

31 Mendelson, C L (1946) Aspiration of stomach contents into the lungs during obstetric anesthesia *Amer J Obstet Gynec* 52 191
32 Klein M D Clahr J Tamis A B and Solkow M. L (1953) Maternal deaths caused by anesthesia in the Borough of the Bronx from 1940 to 1951 *N Y St J Med* 53 2861
33 Stearns A B and Frederickson G C (1957) Promethazine hydrochloride for the control of nausea and vomiting during spinal anesthesia *Illinois med J* 112 267
34 Holmes J M (1956) Prevention of inhaled vomit during obstetric anaesthesia *J Obstet Gynaec Brit Emp* 63 239
35 Editorial comment (1958) *Obstet gynec Surv* 13 333
36 O Mullane E J (1954) Vomiting and regurgitation during anaesthesia *Lancet* 1 1209
37 Coleman, D J and Day B L (1956) Anaesthesia for operative obstetrics value of a cuffed endotracheal tube *Lancet* 1 708
38 Morton H J V and Wylie W D (1951) Anaesthetic deaths due to regurgitation or vomiting *Anaesthesia* 6 190
39 Peel, J (1955) Discussion hazards of anaesthesia in obstetrics *Proc roy Soc Med* 48 1089
40 Morley H A (1956) Maternal death from aspiration asphyxia Correspondence *Brit med J* 1 1416

III. BREECH EXTRACTION

Difficulties in the second stage of breech labour may be due to deficient uterine contractions or to relative or absolute disproportion—extension of the legs can contribute to the latter in addition to causing delay by interfering with lateral flexion of the body. The obstetrician will almost invariably wish to conduct a thorough examination under anaesthesia before he decides on a course of action. In the event of absolute disproportion or of foetal distress in the presence of incomplete cervical dilatation, Caesarean section will probably be carried out immediately and the anaesthetist must be prepared to prolong his anaesthesia on the lines already outlined for this operation. Alternatively if the cervix is fully dilated, the obstetrician is likely to perform a breech extraction an operation which will probably involve considerable intra-uterine manipulation of the foetal limbs. Should no foetal distress be apparent, and the cervix be only part-dilated, the usual course is to allow labour to continue though on occasion the obstetrician may bring down a leg.

It will be apparent that the initial situation demands that the anaesthetist be able to provide some diminution of uterine tone. It is generally agreed that regional analgesia—especially spinal block—is not satisfactory for breech extraction,[3, 4] because of its tendency to be associated with a heightening of uterine activity. Recently Methuen[5] has reported a series of twenty-four breech extractions successfully carried out under epidural analgesia but for the present, anaesthetists would be well-advised to rely on general methods for the conduct of these cases lest they be embarrassed by the need to induce general anaesthesia mid-way through the operation. General anaesthesia should be induced with thiopentone and maintained with nitrous oxide together with the least amount of ether required to produce adequate uterine relaxation. Injection of a pethidine-levallorphan mixture is likely to be of help in limiting the amount of ether needed. Deeper ether anaesthesia will probably be called for if the operation is limited by incomplete dilatation of the cervix. In such a case however the foetus is not likely to suffer from the effects of the drug as delivery will not occur until some time after discontinuance of anaesthesia. It is possible that Fluothane will eventually prove to be preferable to ether in the latter technique. Should complete delivery be undertaken immediately the ether administration should cease as soon as the legs have been brought down.

OTHER CONSIDERATIONS IN BREECH DELIVERY

On the whole breech labour tends to be prolonged, and hence there is

in most instances he apparently plays only a passive part should occasion absolutely no resentment. He can with advantage take over the management of the analgesic technique

During breech delivery there is a considerable tendency for the umbilical cord or the placenta to be compressed, with consequent foetal anoxia By ensuring that the mother receives an oxygen-rich mixture (Trilene in oxygen or 75 25 nitrous oxide oxygen) the anaesthetist can counteract the ill-effects of this to a possibly significant degree By using the same mixture of gases and encouraging the mother to overbreathe during delivery of the head, the anaesthetist can help greatly in reducing the rate of this delivery and with it the incidence of intracranial haemorrhage which is one of the main causes of perinatal mortality associated with breech delivery

Finally there is no certainty that the obstetrician will not have to undertake an assisted breech delivery

ii ASSISTED BREECH DELIVERY

For patients in this category the obstetrician delivers the head with the aid of forceps or by jaw and shoulder traction Diminution of uterine tone is not specifically required and the manoeuvre can be satisfactorily performed under pudendal block [2] However the block cannot be carried out easily or safely once the foetus has been delivered as far as the shoulders Although the obstetrician will wish to avoid haste in delivery because of the danger of producing intracranial haemorrhage delay must also be kept to a minimum because in these circumstances there is very frequently considerable compression of the cord persisting until delivery is completed Rapid induction of anaesthesia, without the provocation of breath-holding or straining is therefore essential and the use of either thiopentone (150 mg -.50 mg) or cyclopropane is recommended The disadvantages of the latter drug in relation to foetal depression (see previous chapter) are not likely to be significant in these cases in which only a short time elapses between induction of anaesthesia and the cessation of placental transmission whereas thiopentone followed by 50 50 nitrous oxide oxygen would probably in a series of patients give rise to more instances of dangerous struggling on the part of the mother

The provisos regarding the possibility of vomiting or regurgitation as discussed in the previous chapter must always be borne in mind. If there is good reason to suppose that the volume of gastric contents is at all significant then pudendal block performed before delivery starts must be the method chosen

under continuous epidural analgesia are likely to have been allowed to eat and to drink during their labour and thereby placed in greater jeopardy should general anaesthesia be required.

2 Other Abnormal Presentations

Persistent occipito-posterior position (deep transverse arrest of the head) is usually dealt with by manual or instrumental rotation of the head, followed by delivery with forceps The anaesthetist must provide some measure of uterine relaxation together with complete relaxation of the pelvic floor musculature and the technique has been discussed in the previous chapter Many cases of face presentation pose a similar anaesthetic problem when vaginal delivery is to be undertaken and the foetus remains viable and the same remarks apply to cases of transverse lie with shoulder presentation If the anaesthetist is suddenly and unexpectedly confronted with a patient whose labour falls into any of these categories he must immediately appreciate that there are several important concomitants to the condition labour will almost certainly have been prolonged and thus inquiry must be made regarding the state of fluid balance and details of oral intake There is notoriously a high perinatal mortality rate associated with these conditions partly referable to trauma—which the anaesthetist can help to reduce by providing adequate relaxation—and partly to prolonged anoxaemia—which must be reduced to a minimum by meticulous anaesthetic care and anticipated by the provision of resuscitative measures immediately following delivery It is worthy of emphasis that in cases of shoulder presentation not only is the lower uterine segment extremely thinned but also owing to the draining away of the liquor the foetus is tightly gripped by the uterus The use of spinal analgesia in these cases makes delivery—whether vaginal or abdominal—very difficult and greatly increases the danger to the child.

3 Multiple Births

Delivery of multiple births is usually effected by the natural processes and the services of an anaesthetist are not required. However if anaesthesia is needed—possibly for version or forceps delivery of the second twin—it must be remembered that these infants as in the case of breech presentation are very commonly premature Uterine tone does not provide a handicap in this condition and only light anaesthesia will be required. Pudendal block together with hypoaesthesia or inhalation analgesia administered by the anaesthetist will usually be sufficient

As previously noted, both Guttmacher[6] and Little and Friedman[7] have

popular concern about the danger of vomiting when general anaesthesia is employed. *Such an attitude implies a complete inversion of the logical* approach. When a patient with a breech presentation is admitted in early labour it must be accepted that she is a very likely candidate for anaesthesia during the subsequent 12-36 hours. There is no excuse for failing adequately to maintain her hydration solely by the intravenous route. Should the local feeling be strongly influenced by fears of the acid-aspiration syndrome, then as further precautions a Ryle's tube can be left in situ and a small volume of a suitable alkali mixture regularly administered on the lines suggested by Dinnick.[5]

The considerable period of warning provides the anaesthetist with an excellent opportunity of giving the pethidine-levallorphan-promethazine mixture previously described, about 15 minutes before a proposed operative procedure. In association with pudendal block this will certainly be adequate for spontaneous breech delivery and for an assisted delivery. In many instances it will provide sufficient hypoaesthesia for breech extraction or for bringing down a leg but should a deeper plane be required or should Caesarean section be indicated, induction and maintenance of general anaesthesia will be carried out relatively easily with small amounts of the agents chosen.

There seems to be little point in confining the local analgesic block to the line of the proposed episiotomy as described for spontaneous breech delivery. Because delivery so frequently becomes more complicated obstetricians should be encouraged routinely to undertake pudendal block which takes only a couple of minutes longer and involves no increased risk for the patient.

The use of continuous epidural analgesia has been strongly recommended in many quarters for the conduction of breech labour and delivery. An outstanding advantage of the method is the absence of centrally-depressant drug action on the foetus, a factor of added importance because in a high proportion of cases breech presentation is associated with prematurity. However, whilst epidural analgesia is undoubtedly relatively satisfactory for spontaneous and assisted breech delivery and under some circumstances Caesarean section, it cannot be relied upon to give adequate operating conditions for thorough examination, breech extraction or bringing down a leg. Furthermore should the breech presentation be found to be associated with placenta praevia, epidural analgesia is contraindicated. The superimposition of general anaesthesia upon regional block is neither aesthetically satisfying nor conducive to ideal patient-doctor or anaesthetist-obstetrician relationships, especially when the change of course occurs in mid-operation. Further, patients

ment of retained placenta associated with prolonged adherence to the placental site

In these cases the anaesthetist must remember that resuscitation of the patient is within the scope of his speciality and he must assume full responsibility for seeing that a transfusion is set up before the operation commences In a proportion of cases previous efforts by the obstetric attendant will have resulted in considerable uterine haemorrhage and the only hope of saving the patient will lie in emptying the uterus as quickly as possible Under these circumstances the anaesthetist must arrange for a transfusion (if it is not already in progress) to be started immediately either by himself or by another competent attendant Naturally blood is the transfusion fluid of choice, and must eventually be given but if matched-blood is not immediately available whichever of the usual intravenous fluids is to hand must be used. Induction should be rapidly carried out with the patient preferably in the Trendelenburg position In the shocked and exsanguinated patient thiopentone is contra-indicated. Cyclopropane with a high oxygen flow presents probably the best form of anaesthesia under these circumstances because of the well-established property of this agent to conserve the coronary and cerebral blood-flows in the presence of hypovolaemia [9] However it is imperative to remember that cyclopropane should not be used if vaso-pressor agents or Pitocin have recently been administered. Ether given by open-drop in domiciliary practice or following a nitrous oxide/oxygen induction in hospital is the second-choice of anaesthesia but care must be taken to avoid the production or enhancement of uterine atony It is highly unlikely that deep anaesthesia will be required in these cases

If there has been only slight overt or concealed haemorrhage and the patient is not in a state of shock, the time factor ceases to be of paramount importance In such cases induction of anaesthesia should be postponed until the transfusion is running and blood has been made immediately available Provided that the risks of vomiting and of the coincident administration of vaso-pressors are appreciated, any anaesthetic technique other than spinal block will be satisfactory Spinal analgesia is contraindicated because the associated increase in uterine tone is likely to make the operation both difficult and hazardous

It is in these cases especially under conditions of domiciliary practice that the hypoaesthesia technique of using a pethidine—levallorphan-promethazine mixture is likely to be of outstanding merit Delay in starting is of relatively little importance in the conduct of this operation and the complete absence of the dangers of vomiting and regurgitation together with the modesty of the equipment necessary makes it seem

recently reported that when conduction analgesia is used for twin delivery the second twin tends to run an increased risk. This is apparently related to the fact that there is often need to perform podalic version and breech extraction at the second delivery, and under conditions of increased uterine tone a rise in perinatal mortality and morbidity must be expected The induction of general anaesthesia if it is to be used, must, of course be delayed until after delivery of the first twin in order to keep to a minimum the amount of depressant drugs reaching the second infant

4 Prolapsed Cord

This complication occurs most commonly in association with the conditions already discussed in the present chapter Obviously, the danger is confined to the child, and it has been estimated[8] that the overall foetal *mortality is 50 per cent being higher when the prolapse occurs before* full dilatation of the cervix Management during the first stage of labour consists of either immediate Caesarean section or of digital reposition of the cord Anaesthesia for the former will be on the lines previously discussed for the latter manoeuvre only a light plane of anaesthesia is required, but a hurried induction with possible straining, must be avoided The agents used for anaesthetizing for a reposition of the cord are not of significance as far as the foetus is concerned provided that full oxygenation is maintained, as there is likely to be an appreciable interval between the end of anaesthesia and delivery of the infant The anaesthetist should therefore direct his full attention to the avoidance of maternal vomiting the danger of which might be somewhat increased as cord prolapse can occur in the early stages of labour Unfortunately regional analgesia is contraindicated in this condition because of the dictates of time the danger inherent in positioning the patient for a spinal or an epidural block and the disadvantage of increasing uterine tone

The obstetric treatment of cord prolapse during the second stage of labour consists of immediate delivery either by forceps or by breech extraction and the anaesthetic management is the same as that previously discussed for these operations

5 Retained Placenta

Treatment of simple retention of the placenta in which the placental site is completely disrupted and the organ remains unexpelled due to atony of the uterus or to an obstructing contraction ring requires the services of an anaesthetist only as a final resort when manual removal has to be undertaken Anaesthesia is called for however in the manage-

depend upon the views of the individual obstetrician regarding the safety of the manoeuvre Fluothane offers the possibility of a substitute for ether and would be much less likely to cause the mother an unpleasant period of recovery

8 Eclampsia and Severe Toxaemia of Pregnancy

The aid of the anaesthetist is being sought on an increasing scale in the treatment of eclampsia and severe pre-eclamptic toxaemia The pertinent aspects of toxaemia of pregnancy are hypertension which in the ultimate stage (eclampsia) becomes manifest symptomatically as an encephalopathy progressive renal failure and progressive deterioration of placental function The anaesthetist is likely to be consulted only in the later and more severe stages of the disease the patient having previously not received medical attention or the initial therapeutic measures (consisting mainly of bed-rest, mild sedation and dietary restriction possibly with hypotensive therapy) having failed. The treatment of only those cases in which the foetus is still alive will be considered here for if death in utero has already occurred, anaesthetic management is simplified to the general techniques usually adopted for patients with acute renal failure

If Caesarean section is to be performed whether the patient is in labour or not then epidural analgesia must be the anaesthetist s method of choice As has already been observed there is considerable decrease of placental efficiency in this condition and the improvement of uterine blood-flow resulting from the sympathetic blockade together with the avoidance of drug-induced foetal depression offers the best chance of delivering a viable child Premedication should be given lest the hypertension be increased by emotional stress and this should consist of morphia (gr ⅙-11 mg) and levallorphan (1 0 mg) given intramuscularly 30 minutes before initiation of the block No vaso-pressor agent should be added to the local analgesic used for the skin weal Frequent blood-pressure readings should be noted, and if the systolic blood-pressure falls below 110 mm Hg a nor-adrenaline or neosynephrine transfusion should be started, the rate of administration being regulated to maintain the systolic pressure between 110 mm Hg and 140 mm Hg

For patients in whom operative delivery is not immediately contemplated, continuous and heavy sedation has until recently been the principal form of treatment. There can be little doubt that such therapy is pharmacologically unsound and is likely to lead to iatrogenic disease in both mother and child. Attempts have been made to combine a lesser degree of sedation with hypotension induced with systemically administered drugs O Keefe and his colleagues[11] have described the use of a lytic

likely to become the technique of choice for the management of retained placenta in the home.

Recently Sauer[10] has reported cases of retained placenta which he conducted satisfactorily under pudendal block alone. Sauer considers that manual removal of the placenta entails for the mother no pain of uterine origin, though if cervical contraction renders entry into the uterine cavity difficult, he encourages the patien to inhale some amyl nitrate

6 *Other Operations*

The anaesthetic care of patients undergoing emergency hysterectomy (following rupture of the uterus or unquenchable haemorrhage) or repair of perineal lacerations is, like that for abortion or ruptured ectopic pregnancy no different from the routine used in general emergency surgery and will not be considered in this book.

7 External Version

External cephalic version is performed, almost exclusively before labour commences. It is thus never an emergency operation, and the routine preparation of the patient by preliminary avoidance of food and drink, and by the usual preoperative medication, may be undertaken. Fear of depression of the foetus by the anaesthetic agents should not influence the choice of technique. Contemporary obstetric teaching denounces any strenuous attempt to turn the foetus. Before the anaesthetist is called, version will already have been attempted whilst the mother was awake, and it is advisable to delay subsequent attempts under anaesthesia until the uterus has recovered from its traumatically-induced state of irritable tonicity

The first requisite of the anaesthetic management is to provide good relaxation of the mother s abdominal wall muscles. This can be effected by any of the usual methods including the use of a muscle-relaxant drug Most obstetricians do not demand a flaccid myometrium, as this would appear to offer an invitation to disaster if the operator becomes over-eager However although the uterine muscle should be allowed to retain some tone, its reflex activity should be dampened sufficiently to negate the response of contraction when the operator applies more than slight pressure to the foetal parts. The operation can be performed under thiopentone alone, given in an average dose of 750 mg but this is not advisable if the obstetrician considers that he might have difficulty in disengaging the breech, as the uterine-relaxant effects of the drug are very short-lasting The usual teaching is that ether is the only satisfactory anaesthetic for this operation. The depth of ether anaesthesia provided will

depend upon the views of the individual obstetrician regarding the safety of the manoeuvre Fluothane offers the possibility of a substitute for ether and would be much less likely to cause the mother an unpleasant period of recovery

8 Eclampsia and Severe Toxaemia of Pregnancy

The aid of the anaesthetist is being sought on an increasing scale in the treatment of eclampsia and severe pre-eclamptic toxaemia The pertinent aspects of toxaemia of pregnancy are hypertension which in the ultimate stage (eclampsia) becomes manifest symptomatically as an encephalopathy progressive renal failure and progressive deterioration of placental function The anaesthetist is likely to be consulted only in the later and more severe stages of the disease the patient having previously not received medical attention or the initial therapeutic measures (consisting mainly of bed-rest mild sedation and dietary restriction possibly with hypotensive therapy) having failed. The treatment of only those cases in which the foetus is still alive will be considered here for if death in utero has already occurred, anaesthetic management is simplified to the general techniques usually adopted for patients with acute renal failure

If Caesarean section is to be performed whether the patient is in labour or not, then epidural analgesia must be the anaesthetist s method of choice As has already been observed there is considerable decrease of placental efficiency in this condition and the improvement of uterine blood-flow resulting from the sympathetic blockade together with the avoidance of drug-induced foetal depression offers the best chance of delivering a viable child Premedication should be given lest the hypertension be increased by emotional stress and this should consist of morphia (gr $\frac{1}{6}$-11 mg) and levallorphan (1 0 mg) given intramuscularly 30 minutes before initiation of the block No vaso-pressor agent should be added to the local analgesic used for the skin weal Frequent blood-pressure readings should be noted and if the systolic blood-pressure falls below 110 mm Hg a nor-adrenaline or neosynephrine transfusion should be started, the rate of administration being regulated to maintain the systolic pressure between 110 mm Hg and 140 mm Hg

For patients in whom operative delivery is not immediately contemplated, continuous and heavy sedation has until recently been the principal form of treatment There can be little doubt that such therapy is pharmacologically unsound, and is likely to lead to iatrogenic disease in both mother and child Attempts have been made to combine a lesser degree of sedation with hypotension induced with systemically administered drugs O Keefe and his colleagues[11] have described the use of a lytic

cocktail in the treatment of eclampsia, and Centuro[12] used, in addition hypothermia in treating 6 mothers with eclampsia, 5 of whom were delivered of a living infant. Though the latter heroic measure is unlikely to be applied frequently the sedative-saving property of the phenothiazine derivatives added to their propensity for tending to decrease blood-pressure render them of considerable value in the moderately long-term treatment of severe pre-eclamptic toxaemia It is necessary, however to interpolate a warning regarding the use of chlorpromazine in this way The liver is particularly vulnerable in toxaemia of pregnancy and the repeated administration of chlorpromazine would very probably lead to severe, or even fatal, hepatic failure in a proportion of patients so treated.

In cases of rapidly worsening pre-eclamptic toxaemia and of established eclampsia, the anaesthetic treatment of choice is continuous epidural block. Aspects of this technique were recently discussed by Bryce-Smith[13] and by Foldes and Crawford.[14] A catheter is inserted into the epidural space preferably via the first or second lumbar interspace and threaded 2 or 3 inches cephalad, so that the drug may be injected close to the region of the sympathetic outflow A vaso-pressor must not be used when making the local skin and subcutaneous infiltration but adrenaline (1 200 000) should be added to the solution injected into the epidural space in order to prolong drug-action and to diminish the chances of rapid absorption into the systemic circulation Used in a concentration of 1 5-2 0 per cent, 2-chloroprocaine repeated three hourly appears to be the safest drug to use Though Xylocaine (1 0 per cent) has been recommended, the fact that, in eclampsia both renal and hepatic function are depressed, makes the occurrence of toxic reactions to this drug highly probable.

Blood-pressure readings should be regularly noted, and a dangerous degree of hypotension counteracted with nor-adrenaline or neosynephrine There should be no significant degree of muscle relaxation, or of respiratory depression, when 2-chloroprocaine is used in the concentration suggested. If labour is in progress it will probably be prolonged, though painless Bryce-Smith[13] has noted that when 1 per cent Xylocaine is used, increasing increments of the drug are apparently needed to maintain the fall in blood-pressure for longer than 24 hours This phenomenon is possibly of a similar nature to that following partial sympathectomy in which vaso-constriction and hypertension recur in response to circulating adrenaline and nor-adrenaline and to increased activity of the intact sympathetic vascular fibres It is possible that the best way of counteracting this effect would be to give an Arfonad infusion but such a measure would necessitate constant supervision by an anaesthetist

9 Disordered Uterine Function

In this country Johnson[16 18] has been a noteworthy propagandist of the part which the anaesthetist may play in the management of certain cases of prolonged labour Johnson advocates the institution of continuous caudal analgesia should labour be prolonged for more than 48 hours owing to such disorders of uterine activity as hypotonic inertia hypertonic lower uterine segment inertia, and cervical dystocia. The rationale of the treatment lies in the fact that by inhibiting lower segment and cervical tone and relaxing the pelvic floor musculature the progress of labour is hastened. There are two important addenda to this argument the concomitant ablation of labour pain it is claimed increases the potency and effectiveness of the upper uterine segment contractions and the associated local vaso-dilatation replenishes the impoverished uterine blood-flow characteristic of prolonged labour

Johnson echoes the warning issued by Hingson and Edwards[17] regarding caudal analgesia to the effect that the block must not be initiated until the cervix has reached at least one-third dilatation, lest uterine contractions be completely inhibited. He recommends the use of a 1 5 per cent solution of piperocaine hydrochloride ('Metycaine') given in an initial dose of 40 ml and subsequently in doses of 15 ml at intervals of 30 minutes over a total period of approximately 6 hours Some of the patients in his reported series were delivered within the 6-hour period of the others those whose labour appeared to be progressing favourably continued to receive reinforcement of the block, and the rest (a small proportion of the whole series) were delivered by Caesarean section

Johnson claims that the treatment advocated results in appreciable shortening of labour with much diminution of maternal distress Although there is a raised incidence of malrotation of the head, with resultant increase in the difficulties of forceps delivery the associated Caesarean section rate is decreased and there is a marked overall improvement in the figures of perinatal salvage The author has had no personal experience of the application of this technique but it undoubtedly is a rational line of therapy and anaesthetists should be ready to offer such a service when the occasion presents However on general principles a continuous lumbar epidural block would probably be preferable to a continuous caudal In skilled hands (a requisite for both techniques) the total failure rate associated with lumbar block is lower than that with caudal there is less likelihood of contamination if the third or fourth lumbar interspace is preferred to the sacral hiatus and the extent of the block can be obtained with similar ease using either technique For

reasons previously discussed, 2-chloroprocaine with adrenaline it is suggested, offers a wider margin of safety than does piperocaine

It will be noted that patients included in both this and the previous group who are treated with a continuous epidural block, may be prepared for Caesarean section or for forceps delivery merely by altering the concentration and volume of the analgesic solution injected.

10 Associated Maternal Disease

A Heart Disease

The cardio-vascular changes occurring during the course of normal pregnancy and labour have been discussed in the opening chapter Heart disease in pregnancy is almost solely rheumatic in origin, and the most commonly affected valve is the mitral. In untreated cases the mortality rate in patients with heart disease who become pregnant is 10 per cent.[18] It is generally accepted that this rate can be reduced to less than 2 per cent when adequate treatment is instituted.[19] However working under the influence of a community which disavows the practices of contraception, sterilization and therapeutic abortion the Dublin school has demonstrated [0] that the incidence can be reduced still further

Only patients with the more severe stages of heart failure with incipient or actual decompensation are likely to be presented as a problem for the anaesthetist. Heart disease alone is now not commonly accepted as an indication for Caesarean section Occasionally the operation is performed upon primigravida or in patients who exhibit a degree of disproportion or other anomaly which makes it seem likely that labour will be prolonged. In such cases the anaesthetic management need not differ from that outlined in Chapter IV

Analgesic technique for labour progressing in the presence of symptomatic heart disease must be directed towards ensuring continuously adequate oxygenation good relief from pain and emotional distress and avoidance of straining During the early stages the regime of medication should follow the lines laid down in Chapter III though if the mother is cognisant of her peril it would be as well to include a tranquillizing drug such as promethazine in the scheme The relative merits of regional and general analgesia for the conduction of the second-half of labour and of delivery pose some interesting problems Labour and delivery in the presence of heart disease are commonly accepted as being characteristically easy and rapid. Actually to cause a slowing of labour and virtually to assure the necessity of a forceps delivery by instituting an epidural block would seem to be an unwarranted therapeutic intrusion However there can

be no doubt that the almost complete relief from pain and the virtual elimination of straining provided by epidural block play a significant part in protecting a badly over-burdened heart Furthermore as Hingson and Edwards[18] point out the bloodless phlebotomy produced by the epidural injection can relieve the heart of the burden of a high venous return

Montgomery and his colleagues[21] have drawn attention to the fact that cardiac distress often increases dramatically immediately after delivery as the venous return is increased by the great reduction in uterine blood-flow the release of the pressure exerted by the gravid uterus on the inferior vena cava and the increased amplitude of respiration Vasodilatation following epidural block would tend to permit a more gradual accommodation to the effects of emptying the uterus

Further investigation of the relative merits of the methods of analgesia needs to be pursued. If general analgesia is undertaken the commonly employed inhalational methods are contraindicated A qualified medical practitioner—preferably of course an anaesthetist—must himself administer 50 50 nitrous oxide and oxygen or Trilene in oxygen if these agents are to be used. Levallorphan must be given with each injection of pethidine to avert any tendency to maternal respiratory depression Promethazine will be found to be a useful adjunct as already described The patient should be encouraged to breathe from an oxygen-enriched source throughout the second stage and during the latter part of the first stage of labour

If a forceps delivery is undertaken it would preferably be performed under a pudendal block, if continuous epidural analgesia is not already being conducted. Caesarean section is probably best carried out under epidural analgesia with the patient sedated with promethazine and possibly pethidine plus levallorphan If general anaesthesia is employed for Caesarean section or for forceps delivery the anaesthetist must ensure absolute avoidance of struggling and breath-holding Thiopentone induction followed by intubation under a relaxant drug and sustained intermittent positive pressure on the lines suggested by Montgomery and his colleagues [21] is presented as the best method for these patients

B DIABETES

Although since the introduction of insulin the diabetic woman is no longer specifically jeopardized by becoming pregnant the associated foetal mortality-rate is depressingly high estimates ranging from 25 to 40 per cent [22] The risk of intra-uterine death occurring becomes significant after the thirty-sixth week Furthermore the foetus tends to be larger

than the average during the later stages of development and thus there is an increased possibility of disproportion at term. A third factor to be noted is that the incidence of pre-eclamptic toxaemia is very high in diabetics and thus an unduly large foetus has to rely upon a relatively insufficient placenta Because of all these factors the customary management of pregnancy in the diabetic is to perform an elective Caesarean section at about the thirty-sixth week. Unfortunately, it is found that the neonatal death-rate is still alarmingly high (see next Chapter) but the overall perinatal mortality-rate has been reduced by this measure

Because of the precarious state of the foetus the use of depressant drugs which cross the placenta must be kept to an absolute minimum in the anaesthetic management of these patients and epidural analgesia is strongly indicated. If this is beyond the technical ability of the physician concerned then spinal analgesia should be employed, but with meticulous attention to the details outlined in the previous chapter

As in all other branches of surgery the anaesthetist must assure himself that the patient has received her pre-operative glucose intravenously and not by mouth, and that her insulin requirements have been satisfactorily met

c Respiratory Disease

The anaesthetic management of a tuberculous patient in labour does not pose any great problem The routine methods of analgesia may be undertaken and equipment used for inhalation analgesia should be disinfected in the usual way after delivery Occasionally forceps delivery is performed to cut short the second stage of labour In such a case pudendal block or conduction analgesia is to be preferred to general anaesthesia These same general remarks may be applied also to the management of patients who develop an acute respiratory infection prior to delivery Increased care must be taken to ensure that the patient does not suffer from any degree of oxygen lack.

REFERENCES

1 Brews A (1957) Eden and Holland's *Manual of Obstetrics* 11th ed p 350 London Churchill.

2 Methuen, D (1958) In Discussion The breech *Proc R Soc Med* 51 163

3 Law R. G and Ransom S G (1954) Anaesthesia in hospital breech delivery *Brit med J* 1 562

4 Burge E S and Baldwin C E (1956) Use of spinal anesthesia in obstetrics at the Evanston Hospital *Amer J Obstet Gynec* 71 973

5 Dinnick O P (1957) In Discussion on anaesthesia for obstetrics an evaluation of general and regional methods *Proc roy Soc Med* 50 547

6 Special Committee on Infant Mortality (1957) Panel discussion Obstetric anesthesia and analgesia *N Y St J Med* 57 2532
7 Little W A and Friedman E A (1958) Anesthesia for the twin delivery *Anesthesiology* 19 515
8 Brews A (1957) Eden and Holland s *Manual of Obstetrics* 11th ed p 377 London Churchill
9 Etsten B Reynolds R N Li T H (1955) Effects of controlled respiration on circulation during cyclopropane anesthesia *Anesthesiology* 16 365
10 Sauer H H. A (1958) Manual removal of the placenta under local anesthesia *Obstet Gynec* 12 221
11 O Keefe W P Shanahan J and Quane M B (1955) Chlorpromazine in eclampsia *Irish J med Sci* Sixth series No 351 p 124
12 Centuro A (1953) So-called artificial hibernation in the treatment of eclampsia *Riv Ostet Ginec* 8 747
13 Bryce-Smith R (1957) Role of the anaesthetist in eclampsia *S Afr med J* 31 1015
14 Foldes, F F and Crawford J S (1958) *Epidural Analgesia in Gynecology and Obstetrics* Paper presented at the Congress of the Scandinavian Society of Anesthesiologists Gausdal Norway Sept 1958
15 Johnson T (1954) Continuous caudal analgesia experience in the management of disordered uterine function in labour *Brit med J* 1 627
16 Johnson, T (1957) 'Prolonged labour a clinical trial of continuous caudal analgesia *Brit med J* 2 386
17 Hingson R. A and Edwards W B (1943) Continuous caudal analgesia in obstetrics *J Amer med Ass* 121 225
18 Hingson R. A and Hellman, L. M (1956) *Anesthesia for Obstetrics* 1st ed p 20 Philadelphia Lippincott
19 Gibberd, G F (1955) *Short Textbook of Midwifery* 6th ed p 258 London Churchill
20 Drury M. I O Driscoll M K. Hanratty T D and Barry A P (1954) Rheumatic heart disease complicating pregnancy *Brit med J* 1 70
21 Montgomery J B Parkhouse J and Prebble S E (1958) Heart failure in obstetrical anaesthesia *Anaesthesia* 13 33
22 Brews A (1957) Eden and Holland s *Manual of Obstetrics* 11th ed p 169 London Churchill

CHAPTER VI

THE CHILD

EVEN a compressed review of contemporary knowledge of the important physiological aspects of perinatal life would be of such length as completely to unbalance the present book as it was originally conceived. In this chapter therefore remarks will be confined to pertinent and very broad generalizations on aspects of this subject as they influence directly the day-to-day work of the obstetric anaesthetist Apologies are offered to specialized workers in this important and advancing field, for any tendency to dogmatism which might appear in these pages Such a tendency is the penalty for abbreviation, and the general reader is asked to remember that our present views, especially on such matters as neonatal respiration and perinatal circulation are in a state of marked flux which, though exciting is on occasion bewildering

1 Physiology

At birth the infant has a red cell count of 5 0–5 5 million per c.cm with a normal range of about 1 million either way[1] [2] The haemoglobin concentration is approximately 18 gm. per 100 ml. blood but is frequently found to be considerably higher *It is worthy of note that samples* of blood obtained from the heel capillaries consistently show a higher concentration of red cells and haemoglobin than do those from the peripheral venous blood, and it is generally advisable to study blood from the latter source when haematological or biochemical investigations are undertaken The values just considered begin to change radically within a few hours of birth, but such matters are beyond the terms of reference of this book.

There appears to be little general agreement on what figure represents the normal blood volume at birth. Estimates range from 7 5 per cent[1] to 10 per cent[3] (expressed in litres) of the body weight (expressed in kilograms) For a normal 7½ lb (3 500 gm) infant this would represent a range of 260–350 ml. of blood. It is widely accepted that the full-term infant may receive 100–125 ml. of blood from the placental vessels including about 15 ml from the umbilical cord.[4] The part which this

extra volume may play in pulmonary function will be discussed later As a mere systemic circulation expander and an additional source of haemoglobin its importance to the neonate is still in doubt. It is claimed that rapid adjustment will result in the passage of most of the added extra-cellular fluid into the extravascular compartments and that the increased iron supply becomes of possible advantage only when the infant is two or three months old. We cannot with certainty say whether or not the transfusion of this extra 100 ml of blood is to be considered as being normal from a biological point of view for if delivery occurs in the squatting position the baby arrives at a level probably only a little lower than that of the placenta, and the cord is likely often to be so taut as to make its value as a transmitting tube greatly diminished.

Of greater moment is the question of drainage of blood from infant to placenta. Gunther[5] has attempted to show that by holding the baby about 15 cm. above the level of the vulva with the cord intact—representing a hydrostatic pressure difference of 12 mm Hg between infant and placenta—for a very short time the infant can be caused to lose up to 26 gm. weight, presumably due to siphonage of blood into the placental vessels Apgar[6] has queried the occurrence of such a process on the grounds that the force of uterine contractions is likely to counteract any head of pressure which it is possible to produce by elevating the infant. However as the tension within the resting uterus is said to be about 15-25 mm Hg the pressure being increased by 60-75 mm Hg during contraction[7] and the neonatal systolic blood-pressure is varyingly stated to be between 69 mm. Hg[8] and 80 mm Hg[1] with a diastolic of 46 mm Hg[1] it would seem that the addition of a hydrostatic pressure-head of 12 mm Hg would make Gunther's suggestion quite feasible The threat of a 7 5-10 0 per cent depletion of neonatal blood volume makes it advisable that the infant should not be held above placental level prior to clamping the cord, especially when the infant is already in distress

Apparently premature infants at least from the thirty-fourth week onwards possess a range of haemoglobin concentration red cell count and blood volume relationship to body weight identical to that of the full-term infant. However the placenta associated with prematurity contains relatively more blood than does that delivered at term with a consequent increase in the ratio of placental blood volume to infant blood volume It is thus possible to produce a most significant degree of hyper-volaemia, and a relatively marked degree of hypovolaemia by holding the premature infant below or above the level of the placenta

The pertinent biochemical data regarding foetal and neonatal blood have been briefly discussed in Chapter II It has been pointed out that

foetal blood has a higher affinity for oxygen at low pressures than has adult blood Wintrobe[2] states that whilst at the twentieth week of pregnancy 94 per cent of the haemoglobin of the foetus is of the foetal type the proportion at birth has fallen to between 55 per cent and 85 per cent Thus with progressing maturity there is decreasing specific affinity

In the normal infant at birth, umbilical vein blood carries oxygen at a partial pressure of 50 mm Hg As already pointed out Apgar and her colleagues[9] consider that this momentary asphyxia is a normal concomitant of the birth process These workers also reported very marked variations in the oxygen tension found in blood taken from the umbilical artery, with saturations ranging from 0 to 50 per cent (mean 22 per cent) in apparently normal infants The variation in partial pressure of carbon dioxide was not so marked, the average values being about 55 mm Hg in the umbilical artery and 43 mm Hg in the vein Referring to the investigations of Dawes and his colleagues[10] (see Fig 1) the New York group postulate that the values found in the umbilical artery blood represent those of the blood reaching the neonatal tissues—including the brain—at the moment of delivery The mean umbilical artery buffer base concentration was found to be 41 5 mEq per litre Thus under optimal conditions the normal infant is born in a mildly asphyxiated condition and with a slight respiratory acidosis However it is becoming more definitely apparent that this phase is not reflective of the state of the child prior to delivery The previous concept characterized by Eastman[11] as one of Everest in utero is not to be accepted as applying under normal circumstances Recently some remarkable studies carried out in Stockholm[12] have revealed by direct photography a satisfyingly pink foetus lying in utero attached to the placenta by a pink umbilical vein and blue umbilical arteries Admittedly these investigations were made on mothers between the fourteenth and eighteenth weeks of pregnancy prior to the induction of therapeutic abortion but there is reason to believe that similar findings will result from studies carried out on more mature foetuses (In fairness it must be added that it is rather difficult to reconcile these findings especially that of a blue umbilical artery and a pink skin with those of Dawes and his colleagues[10] This is a matter for further investigation)

According to Apgar and her colleagues[13] the percentage oxygen saturation of arterial blood is not a satisfactory index of the degree of depression of a neonate and nor is the tension of carbon dioxide The severity of metabolic acidosis as indicated by a depressed *p*H or buffer base concentration reflects more closely the status of the infant Under favourable circumstances respiratory and metabolic acidosis with associated

anoxaemia, are rapidly corrected by the initiation of pulmonary respiratory activity

It is now fairly well established that full ventilation of the lungs is normally achieved very shortly after delivery[14] Cross and his colleagues[15] give the following details regarding pulmonary activity in the neonate

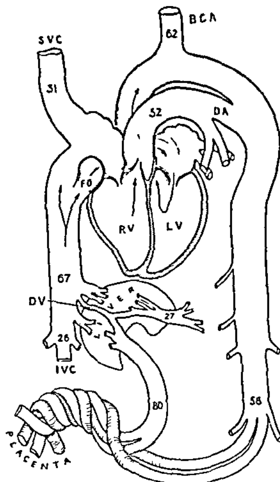


FIG 1 Diagram of the foetal circulation. The figures indicate the percentage oxygen saturation of blood withdrawn simultaneously from various vessels and averaged from determinations on 6 lambs I V C inferior vena cava S V C superior vena cava D V ductus venosus F O foramen ovale D A ductus arteriosus B C A brachiocephalic artery

(Reproduced from Born G V R. Dawes G S Mott J C and Widdicombe J G (1954) Changes in the heart and lungs at birth Cold Spring Harbor Symposium on the Mammalian Fetus 19 102 By kind permission of Dr Dawes and of the publishers)

They are substantially the same as those published earlier by Cook and his co-workers[16] in Boston.

TABLE I

	Full-term Infants	*Premature Infants*
No of observations	47	21
No of infants		
Male	25	8
Female	17	6
Total	42	14
Age range (days)	0·19–11 13	0 56–14 31
Mean wt. in kg and standard deviation (S D)	3 26– 0 404	1 87 0 183
Mean min. vol. (ml) and S D	487 40–81 67	343 90–57 46
Mean respiratory rate and S D	30 99– 7 13	32 40–10·68
Mean tidal air and S D	16 50– 3 53	11 42– 3 33
Mean O consumption/kg /hr and S D	419 11–53 45	418 38–69 18
Mean CO_2 production/kg /hr and S D	326 33 48 15	330 14 74 24

(Reproduced from Cross K. W Tizard, J P N and Trythall, D A. H (1957) Gaseous metabolism of the newborn infant *Acta paediat* 46 265 By kind permission of Dr Cross and of the publishers)

Cook and his co-workers[16] concluded that average values for minute volume tidal volume alveolar ventilation and functional dead space (the latter averaging 5 ml for a . 5 kg infant) for infants of different size and maturity varied directly with the infant body weight The respiratory rate appeared not to be closely related to body weight though a tendency for the smaller children to exhibit a higher rate was observed.

1 The First Breath

The preceding data refer of course to established respiratory activity and are presented as a basis of reference to be used in assessing degrees of abnormality and as an objective to be pursued when treatment is instituted. Of prime interest to the anaesthetist is the mystery surrounding the initiation of sustained respiration

There has been recorded a multitude of views on the stimulus which provokes the infant to take its first breath, much of the interest and knowledge stemming from Sir James Barcroft s original researches There seems little point in detailing these theories here as they are well established in the folk-lore of medicine Evidence of co-ordinated quasi-purposeful foetal respiratory activity is now generally accepted but the significance of this in the scheme of initiation of extra-uterine breathing is no better founded than is the significance of a relationship of limb movements in utero to the activities of walking and running

The most tenable view appears to be that in the normal relatively non-depressed infant respiration is initiated reflexly by tactile stimulation In this regard, the more sensitive parts of the body surface appear to be the snout area and, of considerably less significance the soles of the feet Once the initial full gasp has been taken in the presence of an adequately functioning nervous system the maintenance of respiration appears dependent upon precisely those factors which govern respiratory activity throughout life namely central nervous and chemoreceptor response to oxygen carbon dioxide and acid-base shifts

A few hours after delivery the intrathoracic pressure-changes under conditions of quiet respiration approach those found in the adult but a very much greater negative pressure is produced in the effort of drawing the first breath Donald[14] has been able to demonstrate a negative intrathoracic pressure of 80 cm water during the initial inspiration with a swing of over 40 cm water during the first few breaths of life The main provocation of this very great effort is the need to overcome the cohesion of the alveolar and bronchiolar walls of the atelectatic lungs It is accepted that prior to delivery the lungs contain amniotic fluid. The entry of such fluid, as P Gruenwald[16] has pointed out does not involve the combating of any degree of surface tension However immediately upon normal delivery presumably in response to the initial inspiratory effort and to the opening up of the vast pulmonary capillary system much of the intra-alveolar fluid is absorbed, the fluid within the bronchioles either taking its place or itself being absorbed. The resultant stickiness of the terminal pulmonary ducts is the main cause of the greatly increased resistance to the entry of air A strong body of opinion now holds[5, 17] that this resistance is considerably reduced if the pulmonary capillary bed becomes thoroughly and rapidly engorged. The turgidity of the vessels so produced possibly lessens the elastic resistance of the lungs to inflation and in addition helps actively to push apart the applied surfaces of the alveoli and bronchioles

It will be apparent that the premature infant with its relatively weak respiratory musculature and its compliant bony thoracic cage is in urgent need of all the help it can get to reduce the effort required to overcome resistance to its initial inspiration It is mainly for this reason that Gunther[5] urges that the premature infant should not be held above the level of the placenta lest the resultant hypovolaemia lead to inadequate filling of the pulmonary vessels The same argument will hold good in the case of any infant whose efforts are likely to be impaired as a result of central depression Bonham Carter[17] has suggested that the production of a mild hypervolaemia in premature infants will by raising the central venous

pressure ensure optimum conditions for rapid lung aeration but there are other aspects to this question and it will be discussed later

II NEONATAL DEPRESSION AND RESUSCITATION

In essence, neonatal depression implies complete or partial failure rapidly to establish adequate unaided ventilation A degree of hypoxia is therefore a concomitant though not, as explained earlier an index, of the state of depression It is most important for the purposes of analysing the causes of depression and the efficiency of therapeutic measures taken to counteract it as well as for providing an immediate guide to treatment that some accepted scale of connoting the general status of the newborn be established. The hallowed terms 'asphyxia pallida and asphyxia livida are worthless in this regard. It is suggested that the scheme propounded by Dr Virginia Apgar[18] (Table 2) be generally adopted, and that each neonate s score according to the Apgar scale be recorded on the appropriate case-sheet A further concept of Apgar s[19] which could with advantage be brought into general use is that of the time to sustained respiration (T S R.), which is probably of greater worth than the recordings of breathing time and crying time

TABLE II

Sixty seconds after the *complete* birth of the infant (disregarding the cord and placenta) the following five objective signs are evaluated and each given a score of 0 1 or 2 A score of 10 indicates an infant in the best possible condition

	0	1	2
Heart rate	Absent	Slow (below 100)	Over 100
Respiratory effort	Absent	Slow Irregular	Good Crying
Muscle tone	Limp	Some flexion of extremities	Active motion
Response to catheter in nostril (tested after oropharynx is clear)	No response	Grimace	Cough or sneeze
Colour	Blue Pale	Body pink Extremities blue	Completely pink

(Reproduced from Apgar V (1953) Proposal for new method for evaluation of newborn infant *Anesth & Analg* 32 260 By kind permission of Dr Apgar and of the Editor)

The first measure which must be taken following delivery is to clear the infant s mouth and pharynx of mucous and amniotic fluid. It is of course preferable that this be done after delivery of the head in cases of

vaginal delivery As the normal infant tends to be a compulsive nose-breather attention should be paid to clearing the nares The types of apparatus in use for this performance will be discussed in the next chapter Although Potter[20] has said that the contents of the mouth and pharynx are usually inhaled without ill-effect during the first inspiration and that plugging of a bronchus with mucus sufficient to interfere with the establishment of extra-uterine respiration is of almost unknown occurrence it seems good sense to clear as much fluid as possible from the upper respiratory passages that the first inspiration may consist mainly of air

The toilet described will take up sufficient time and involve enough stimulation of the sensitive snout area to enable a reasonable estimate of the infant s condition to be made at the one-minute stage advocated by Apgar[18] If the child s score is 7 or over it is unlikely to need further active attention as regards its vital physiology and, its cord having been cut, it should be placed on a sloping surface with a head-down tilt of about 15-20 degrees Thereafter the mouth should be fairly frequently aspirated, as mucous and liquor invariably drain into it for some time after delivery

There is a suggestion[21] that following Caesarean section the infant s stomach should be aspirated through a fine rubber catheter—after respiratory activity has become well established—lest subsequent regurgitation and inhalation lead to pulmonary complications Whilst this might be a sensible prophylactic measure in the case of the premature infant, the value of its routine application has not been convincingly demonstrated

If at the time of initial assessment the infant appears to be satisfactory this is no excuse for leaving it to fend for itself during the next couple of hours Its condition might well be likened to that of the general surgical patient who on extubation appears to react well and to have a satisfactory tidal volume but who in a few unfortunate instances is allowed by a negligent anaesthetist to return immediately to the ward, where depression and regurgitation supervene The custom of serving coffee or tea in the labour ward office at least after every operative delivery is one to be encouraged wholeheartedly by all—including the hospital administrators After the party a social call should be paid upon both mother and child by the obstetrician and the anaesthetist This does not of course preclude the necessity of having a nurse attendant upon the patients during the whole time

If it is apparent that the child is depressed, then resuscitation must be undertaken immediately After the first 60 seconds there is absolutely

no place for the attitude of watching to see if the child *will* take a gasp Depression means anoxaemia prolonged anoxaemia means increasing depression and in a spiral fashion the circulatory adjustments—especially of the pulmonary system—the viability of the cortex and the efficiency of the vital centres are increasingly compromised if time is wasted by a policy of waiting for the anoxic drive to become effective The first and only important measure after clearing of the upper air passages is the administration of oxygen Even should feeble respirations have started if depression is present oxygen must be given If there is no cardiac impulse or umbilical pulsation and the child is not obviously long dead attempts to stimulate the heart with needles drugs or electric shocks are sheer procrastination and will succeed only if adequate oxygenation would have succeeded—though the converse very likely does not hold Slapping the child throwing it around (albeit with the elegance of a rocking motion) anointing it with hot and cold water insulting its anus—all these indulgences one would have thought to have been long consigned to the dustbin of history but they are unfortunately still to be observed on occasion They have no place in sane medical (or nursing) practice Oxygen is the sole agent of resuscitation and if it is not immediately obtainable in pure form the attendant must give of his own supply (see next chapter) There was a fashion for giving carbon dioxide with the oxygen this too makes no sense As previously described, the infant has been building up an embarrassing surplus of carbon dioxide since the moment when delivery started and it continues to accumulate the gas as apnoea persists In a depressed infant the stimulant phase of the actions of carbon dioxide and acidosis has passed and only depression of increasing severity is to follow To supplement this with yet more carbon dioxide is sheer folly

Neonatal depression is likely to be due to one of two main causes primary anoxia occurring during labour or delivery with or without associated intra-cranial haemorrhage and central nervous depression due to drugs administered to the mother The main line of treatment is the same whatever the cause but whilst inaugurating resuscitative measures the anaesthetist should make a rapid assessment of the likely aetiology If any of the narcotics is implicated levallorphan (0 1 mg) should be injected into the umbilical vein It is possible that barbiturate-induced depression might be counteracted by the administration of amiphenazole but there is no dosage which can be reliably advocated, and the danger of overdosage with consequent excessive central stimulation is sufficient to make it advisable not to use this antagonist in neonates at the present time There is no point and indeed probably danger in attempting a

pharmacological reversal of depression due to other analgesic and anaesthetic agents

For a mildly depressed child (scoring say 5-7 points), the administration of oxygen at a flow-rate of about 2 l per minute via a soft tube placed in an unobstructed nostril will probably be adequate Frequent suction must be undertaken as these infants tend to froth a good deal having usually made considerable inspiratory efforts whilst in an environment of amniotic fluid. Suction should be carried out as atraumatically as possible and should be performed infrequently enough to avoid the farce of aspirating directly from the mouth all the oxygen entering through the nose

If depression is somewhat deeper oxygen must be administered under positive pressure In the presence of weak respiratory activity this can be done by using a closely fitting face-mask and applying pressure from a small rebreathing-bag An oro-pharyngeal airway should always be inserted before the mask is applied. This measure is to be regarded as being strictly short-term It provides no opportunity for aspiration of mouth and pharynx and, if continued for longer than about one minute, is likely to lead to embarrassing gastric distension with possible regurgitation After 60 seconds the mask should be removed. If the child's response has been good, its respiratory excursion increased and its oxygenation improved, then it is probable that under the influence of the blossoming pulmonary circulation progress will be maintained, and resort may be made to oxygen via a nasal catheter If there has been no improvement then treatment along the same lines as for a severely depressed infant must be instituted.

A severely depressed child is a weak child, and this is of even greater moment in the premature. Mention has already been made of the effort needed to overcome the resistance to the initial inspiration of air In the type of case under review haste must be made to surmount this first obstacle on the child's behalf. This implies immediate scrupulously gentle endotracheal intubation and the momentary administration of oxygen under a pressure of 40-60 mm. Hg Once the bronchioles and many of the alveoli have been inflated the resistance to subsequent inspirations is of a much lower order and the mechanical efficiency of any respiratory activity undertaken by the infant must be vastly increased There are workers who continue to advocate the giving of oxygen by the method of gastric insufflation This regime should have no place in a scheme of resuscitation of the newborn There is firstly some doubt as to its efficiency as a mode of oxygenation, and the view is held[22] that much of the oxygen reaching the circulating blood does so from the

'pharyngeal overflow', rather than by passing through the gastric mucosa The second objection to gastric insufflation is that if the method is used the child still has to take its first breath unaided and even if the oxygenation is of temporary benefit the considerable and futile effort made to initiate respiration is likely on balance to lead the infant into an even more parlous condition There might be a place for gastric insufflation in supportive therapy as in the case of very small prematures once the fullest possible respiratory excursion has been established but even then naso-pharyngeal catheterization is probably of equal efficiency and is less dangerous

The trachea of an infant is on the average 4 cm long and 5–6 mm in diameter The distance from the gums to the cords is 5–6 cm and from the gums to the carina 9–10 cm Thus the endotracheal tube used should be no longer than 9 cm and no shorter than 7 cm A Portex size 0 or size 00 is of satisfactory diameter The tube should be of the non-cuffed variety with a rounded bevel-end not rigid but firm enough to maintain a gentle curve After use it should be sterilized as in the general theatre and should be kept in its individual cellophane wrapper

Oral intubation must be the rule for obvious reasons It should be performed under direct vision using the sort of laryngoscope blade with which the operator is most familiar The infant epiglottis is notoriously soft and tends to obstruct the view of the vocal cords It may be gently lifted out of the way with the tip of the laryngoscope blade (more easy when a straight blade is used) or with the end of the tube gripped by a short pair of Magill s forceps Except in the presence of disaster or of incompetent care of equipment blind intubation has no place in modern practice There are greater and lesser authorities who advocate this method and proudly demonstrate their aptness at it They tend to forget that their trail is littered with the excoriated mucosae of infants subjected to their early trials and errors The finger and finger-nail—clean or dirty—is no respecter of an infant s mucous membrane

Oxygen is administered from a simple system for which there are only three essentials a reducing valve on the cylinder a manometer and an efficient outlet Intermittency of positive pressure may be achieved by either the use of a bag in the familiar Magill system or the provision of a T-piece The latter should be sited fairly close to the infant s end of the length of tubing which leads from the reducing valve to the endotracheal adapter Fingertip application to the open end of the T-piece allows the production of rapid changes of pressure within the system and this is probably the preferable method as the use of a bag for more than a few minutes invites carbon dioxide retention

The initial pressure as already explained, must be high—of the order of 40-60 mm Hg However of equal importance is the fact that such pressures must be exerted for only a very short time otherwise there is considerable danger of pulmonary bullae formation with possible rupture. Day and his colleagues[23] have indicated that such a range of pressure should be applied for about 0 15 seconds and have stressed that there is a danger of producing structural lung damage if this period exceeds 0·2 seconds * As this indication is of little significance in terms of human capacity to perform, it is probably best to urge that the baby be subject to momentary bursts of pressure not exceeding 60 mm Hg Expansion of the thoracic cage must be taken as an indication that the cohesive effect of atelectasis has been overcome and thereafter the maximum pressure must be maintained below 15 mm Hg In all but the most hopeless cases initial expansion of the lungs will be accompanied by a flushing of the pulmonary circulatory system, and this too will serve to diminish the resistance to oxygen inflow Intermittent positive pressure should be continued at a rate of about 40 inflations per minute until the infant appears to be capable of taking over on its own The endotracheal tube should be left in place for an appreciable time after the latter state has been reached, to avoid the necessity of reintubation should a relapse occur Intermittent aspiration of fluid from the endotracheal tube is a necessary undertaking and after extubation the infant should always be

* Since completing the text of this book, I have had the opportunity of personal discussion with members of the Neonatal Physiology Research Unit at the Sloane Hospital for Women, Presbyterian Medical Centre New York Regarding the scheme of neonatal resuscitation, Dr V Apgar and Dr L. S James have kindly permitted me to record an important new development evolving from a considerable quantity of data as yet unpublished. It is now considered that whilst the figures quoted above—namely 40-60 mm Hg (55-80 cm H_2O) for under 0 2 seconds—are applicable to the excised neonatal rat lung they must be modified to meet the larger capacity presented by the lungs of human neonates Exerting a high pressure for such a short period will not result in the introduction of a volume of air sufficient to inflate the pulmonary tree to any significant degree

The atelectatic neonatal lung will not begin to open until the applied pressure reaches 25 cm H_2O the lungs will expand readily if a pressure within the range 25 35 cm. H_2O is repetitively maintained for 0 5-1 0 seconds with an interval of about 1·0 seconds between applications When such pressure is applied by the trained resuscitator—using the mouth-to-airway technique currently advocated by this Unit—a characteristic sensation of give is appreciated as the respiratory tree expands and thereafter the pressure may be decreased as described in the text

At this lower pressure (35 cm H_2O) time does not appear to be quite as critical in relation to rupture or to bullae formation as with the higher pressures the margin of safety on the evidence of animal experiments being very considerable Above the level of 35-40 cm. H_2O the duration of application of pressure assumes a significance which increases greatly with each successive rise in the pressure exerted provided that a volume sufficient to cause expansion of the lungs is moved into the chest

nursed in an oxygen-enriched atmosphere (for a review of the equipment used for resuscitation and supportive therapy see the following chapter)

The pressures indicated above are to be taken as applying also to the management of the premature infant, as the resistance due to cohesion and to elasticity are of the same order as those found in the infant at term.

Various mechanical contrivances have been introduced at times as aids to resuscitation of the newborn—intermittent positive pressure machines positive/negative phase respirators electro-phrenic stimulators and the like On the whole these have not proved to be of any great merit, and it is strongly felt that, though such machines will come to have an important place in the maintenance of respiration, their use is not indicated in the emergency of attempting to establish breathing It is not to be expected that mechanical or electrical equipment will surpass in efficiency the nicety of hand and eye in providing the control and judgement essential to the conduct of these cases

It will be evident from the foregoing pages that assessment of the degree of depression of a neonate the choice of the therapeutic measures to be taken, and the application of those measures demand both common sense and experience The corollary holds true, and it must be emphasized that no one lacking in either common sense or appropriate experience should ever be allowed to assume control over a depressed neonate All responsible attendants upon delivery—obstetricians anaesthetists paediatricians and senior midwives—should be completely conversant with the scheme of resuscitation, and should be adept at intubation. Intubation of the premature infant demands very considerable skill and care, and should, if possible, be undertaken only by a trained anaesthetist.

Though relatively uncommon, gross anaemia, diaphragmatic hernia, post-choanal atresia and tracheo-oesophageal atresia and fistula are important causes of an infant's failure to establish efficient respiration. They must always be borne in mind and, should they be diagnosed, promptly dealt with in an appropriate manner As Apgar[22] has pointed out, it is wise to remember that 20-30 per cent of cases of maternal hydramnios are associated with foetal abnormalities

Finally it must be remembered that if oxygen therapy is to be continued subsequently to the initial period of resuscitation, the infant must receive the gas in a concentration no higher than 40 per cent. The association of retrolenticular fibroplasia with the administration of a high concentration of oxygen is now well established.

Of recent years the number of live births annually in England and

Wales has been approximately 670 000 Notified still-births amount to about 2 3 per cent of the total live births and of these, about half involve a foetus which has developed normally and satisfactorily up to the onset of labour and which has been killed by asphyxia with or without significant intracranial haemorrhage Thus each year in England and Wales alone (a comparable figure is likely to apply to the whole of the United Kingdom) roughly 7,700 live-born viable infants die before the initiation of respiration In addition the neonatal mortality rate (that is the number of infants who, having once drawn breath, die within a month of birth) in England and Wales is about 11 000 per annum Within this group the majority of deaths occur during the first week of life and the greatest single causative factor is asphyxia—even on the basis of certification 2 300 of the 11 000 die of asphyxia and atelectasis [4] In the United States perinatal (including foetal) wastage is the third highest cause of death,[6] being exceeded only by cancer and heart disease

Our relative failure to make satisfactory progress in this field is notably reflected in the well-recognized failure of the perinatal mortality rate to fall in parallel with the infant mortality rate during the past two or three generations Furthermore although it is obviously impossible to make an accurate estimate it is probably fair to say that for each viable child who fails to survive two or three will emerge from the struggle bearing wounds—probably of a neurological character Although there is yet no clear indication of a relationship between neonatal asphyxia and subsequent cerebral palsy or mental retardation various investigations of this question are in progress [25] and the general informed opinion appears to be that such a relationship will be found It is surely not too far-fetched to see a corollary between the acute hypoxic episode with its neurological sequelae in the adult recently so forcibly brought to the attention of anaesthetists and a state of sustained anoxia in a neonate

To summarize in England and Wales alone a total infant mortality and morbidity rate of about 15-20 thousand per annum is entirely the result of inadequate attention to the danger of asphyxia Investigation and understanding of perinatal physiology is clearly of more than academic importance *

III Regressing Pulmonary Efficiency of the Newborn

There has come to be recognized during the past two or three decades a

* For a very informative discourse on neonatal respiratory physiology the reader is referred to Cook C D Lucey J F Drorbaugh J E Segal S Sutherland J M and Smith C A (1956) Apnea and respiratory distress in the newborn infant *New Eng J Med* 254 562 605 651

syndrome in which the infant, within a short time of attaining apparently adequate ventilation begins to suffer respiratory embarrassment, which is progressive and which almost invariably leads to death within 12-36 hours Outstandingly common is the association of this syndrome with prematurity maternal diabetes and Caesarean section.

At post-mortem examination, the primary pathology is found to be confined to the lungs with secondary changes following the usual pattern consequent upon anoxia. Microscopic examination reveals many of the terminal air passages to be lined with an acellular eosinophilic membrane and surrounded by a large area of collapsed alveoli. This picture is never seen in the stillborn infant. In view of the histopathology the term 'hyaline membrane disease' has been used to connote the syndrome but this does not find favour with all workers (P Gruenwald[6]) as the membrane might be merely the terminal manifestation of a previously reversible process Application of the term 'pulmonary disease of the newborn is also not wholly in favour as it does not carry the implication of an initial institution of apparently satisfactory respiration.

The clinical picture is well defined within a few minutes or at most an hour or two of birth, the infant who in only rare cases has required energetic resuscitation begins to exhibit inspiratory recession, first of the subcostal muscles later of the intercostals In rapid sequence there follow the signs of progressive pulmonary inefficiency with an alert child, in possession of intact vital centres fighting with increasing desperation to draw breath. Cyanosis is uncommon in the earlier stages but later in the course of the disease the infant suffers from cyanotic attacks which appear without warning and which consist of a period of apnoea lasting for one or two minutes Eventually one of these attacks proves to be terminal. It is of course impossible to know whether or not the infants who survive the initial stages of this syndrome of regression have at any time had hyaline membrane formation within their lungs Donald[14] believes that radiological evidence of the membrane is demonstrable

It must be remembered that initially it is difficult clinically to differentiate the syndrome under discussion from respiratory distress due to *aspiration of gastric contents diaphragmatic hernia, pulmonary infection* or intracranial haemorrhage

There are several disputed theories of the causation of regressing pulmonary efficiency The very fact of the relatively recent appreciation of the syndrome offers a challenge The considerable number of cases now seen—0 35 per cent of live births in one notable hospital (V Apgar[6]) —might be merely a reflection of the increased salvage rate of infants especially the prematures or those born of diabetic mothers as compared

with that of earlier years On the other hand, the recent prominence of the syndrome might be indicative of a significant iatrogenic factor possibly concerned with the widespread use of narcotic analgesics or of oxygen therapy

Although regurgitation and inhalation by the infant of its highly acidic gastric contents has been implicated by some workers, most of the contemporary theories of the causation of this disease are concerned with pulmonary haemodynamics As has been pointed out rapid filling of the capillary bed is strongly held to be a necessary requisite for prompt and efficient lung aeration In the presence of hypovolaemia, as might be associated with siphonage of blood from the infant to its placenta, such capillary distension will tend not to be adequate However to postulate hypovolaemia as a cause of regressing pulmonary efficiency on these grounds alone is surely inherently incorrect for in the final pathology the lungs are collapsed, not atelectatic (it is strongly felt that the term atelectasis should be strictly limited to the signifying of lung tissue which has never been aerated collapse' refers to lung tissue bereft of its previously contained gas The terminological confusion can lead to unwitting discrepancies in theory and therapy) On the other hand, if adequate ventilation is attained, despite hypovolaemia, then the suboxygenation attendant upon the relative anaemia, together with a possible low level of plasma protein concentration, might promote some pulmonary exudate.

More attractive are the hypotheses which implicate hypervolaemia as one of the causative factors. It has been suggested[10] that 55 per cent of the combined ventricular output of the foetus passes through the placenta. Upon occluding the umbilical cord therefore, there is a sudden and sharp rise in systemic peripheral resistance. Opening up of the vast pulmonary vascular network rapidly offsets this rise to a considerable extent Dawes and his colleagues[10] have claimed that there is an important intermediate stage in the change-over from the foetal to the adult circulation (see Fig 2) The Oxford group has designated this stage as that of neonatal circulation, and have indicated that during it the ductus arteriosus remains patent, but that in response to the increased peripheral resistance blood-flow within the vessel is reversed, leading now from aorta to pulmonary artery At the same time, the foramen ovale is shut off partly under the influence of the increased pressure in the left atrium. Apparently this arrangement of neonatal circulation is initiated normally within minutes of birth and remains effective for two or three days after which time the ductus arteriosus becomes functionally closed. The effect of the open ductus plus that of a considerable rise in peripheral

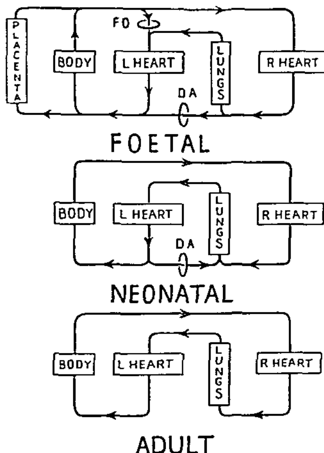


FIG . These figures illustrate in a simplified form, the changes in the circulation at birth. In the fetus both ventricles work in parallel to drive blood from the great veins to the arteries

Tying the umbilical cord stops the placental circulation and the consequent reduction in inferior vena caval flow combined with a great *increase in pulmonary* blood flow causes closure of the *foramen ovale* (F O) These changes occur within a very few minutes of birth and give rise to the neonatal circulation, in which a large volume of blood flows through the lungs because the ductus arteriosus (D A) is still open at the expense of a greater left ventricular output

During the course of the next day or two the lungs become fully functional, and the ductus arteriosus which constricts considerably soon after birth, finally closes to produce the adult circulation, in which blood is pumped through the lungs and body by the two ventricles operating in series.

(Reproduced from Born, G V R., Dawes G S Mott J C. and Widdicombe J G (1954) Changes in the heart and lungs at birth Cold Spring Harbor Symposium on the Mammalian Fetus 19 102 By kind permission of Dr Dawes and of the publishers)

resistance is to increase the pulmonary blood pressure If in addition hypervolaemia is present there is a strong suggestion that pulmonary exudation will result This is even more likely to occur in the case of a premature infant in whom the pulmonary capillaries are possibly more permeable, and whose vascular system immediately prior to delivery contains a smaller proportion of the total circulating blood than does that of a full-term infant.

Thus it is postulated, although respiration is satisfactorily initiated, a pulmonary exudate notably containing fibrinogen (C D Cook[6]) is rapidly produced. It has been suggested that this is acted upon by thromboplastin from the amniotic fluid to form hyaline membrane Apparently the amniotic fluid so involved need not be a residue of that normally present in the lungs prior to delivery It has been suggested by Dawes[10] and by Jost[6] that amniotic fluid may be in part secreted from the tracheobronchial walls or filtered from the alveoli in the foetus This process might well be perpetuated in the premature for many minutes following delivery

It has been stated[10] that at least in the newborn lamb the ductus arteriosus begins to constrict within 5-15 minutes of delivery the diameter being fairly rapidly reduced by half The velocity of blood-flow through the vessel is apparently greatly increased, and there is only a gradual decrease in the volume passing through it, considerable turbulence being promoted. A more marked contraction of the vessel is said to be provoked by relative anoxaemia,[27] probably as the result of the release of pressor amines—and in this connection it will be recalled that in the premature infant the organ of Zuckerkandl is comparatively large and contains a considerable quantity of noradrenaline Associated with this response to anoxaemia there is of course a general systemic vaso-constriction leading to a further increase in peripheral resistance Now Gunther[5] has observed that the umbilical vessels fail to contract in a normal manner when under the influence of pethidine even though the quantity of circulating drug is insufficient to produce obvious vital centre depression It is conceivable that a similar concentration of pethidine might result in an insufficient constrictive response of the ductus arteriosus to sub-oxygenation or even to the normal determining factors with a resultant significant increase in pulmonary vascular pressure

Central depression per se has been postulated as being a primary cause of regressing pulmonary efficiency but this hardly seems to be likely the infant so obviously makes prodigious efforts to achieve satisfactory respiratory exchange The influences of a high concentration of oxygen in the child s environment increased or diminished humidification of the

ambient air and raised or lowered body temperature are of doubtful importance in the production of this syndrome (W A Silverman)[6]

Ignorance of the aetiology of the condition means that treatment can be only symptomatic An attempt is made to augment the infant s respiratory efforts by the use of ventilating devices and thereby not only to maintain its oxygenation but also to conserve its energy One such approach to this problem has been well outlined recently by Donald,[14] and another involving routine tracheotomy by Benson and his colleagues[28] However the success of these methods seems at the present time to be so limited that a discussion of their application appears not to be indicated for a book of this type

It will be observed that in the above rather disjointed presentation of aspects of the syndrome of regressing pulmonary efficiency none of the notable workers in the field have been identified by name with any of the theories presented. This has been a deliberate policy for the subject is extremely complex and hypotheses and even observations appear to change radically from year to year Many factors remain to be elucidated, and their significance evaluated. To the anaesthetist those of more direct interest include the influence of narcotic analgesics the construction of efficient respirators the significance of the relatively large size of the thymus (can this for instance be related to the anomalous response of infants to depolarizing and non-depolarizing relaxants and is the progressive inefficiency of the respiratory muscles of some premature infants subsequent to an initial powerful contraction reflective of a myasthenic state?)

This entire section has been interpolated, not to give an accurate exposition of the views of advanced workers but in the hope of stimulating the interest of anaesthetists who are or who intend to be especially concerned with obstetrics The problems are such as to require for their solution the team work of informed obstetricians paediatricians anaesthetists and laboratory workers

REFERENCES

1 Diamond, L K (1950) In Nelson s *Textbook of Pediatrics* 5th ed p 1093 Philadelphia Saunders
2 Wintrobe M W (1956) *Clinical Hematology* 4th ed. p 105 Philadelphia Lea and Febiger
3 Sandford, H N (1957) In Brennemann and McQuarrie s *Practice of Pediatrics* 3 Chapter 15 p 1 Hagerstown, Md. Prior
4. De Marsh Q B Windle W F and Alt H L (194.) Blood volume of newborn infant in relation to early and later clamping of umbilical cord *Amer J Dis Child* 63 1123

5 Gunther M (1957) 'Transfer of blood between baby and placenta in the minutes after birth. *Lancet* 1 1277
6 Special Committee on Infant Mortality (1958) Panel discussion on Respiratory difficulties of newborn infants *N Y St J Med* 58 372
7 Moir C. (1936) Expulsive force of the uterus during labour *Lancet* 1 414
8 Holland, W W and Young I M (1956) Neonatal blood pressure in relation to maturity mode of delivery and condition at birth *Brit med J* 2 1331
9 Weisbrot, I M James L. S Prince C E Holaday D A and Apgar V (1958) Acid base homeostasis of the newborn infant during the first 24 hours of life *J Pediat* 52 395
10 Born, G V R Dawes G S Mott J C and Widdicombe J G (1954) Changes in the heart and lungs at birth Cold Spring Harbor Symposium on the Mammalian Fetus, 19 102
11 Eastman, N J (1930) Foetal blood studies I Oxygen relationships of umbilical cord blood at birth *Bull Johns Hop Hosp* 47 221
12 Westin, B (1957) Technique and estimation of oxygenation of the human fetus in utero by means of hystero-photography *Acta paediat*, 46 117
13 James L.S Weisbrot I M Prince C.E. Holaday D A and Apgar V (1958) Acid-base status of human infants in relation to birth asphyxia and the onset of respiration *J Pediat* 52 379
14 Donald, I. (1957) Neonatal respiration and hyaline membrane *Brit J Anaesth* 29 553
15 Cross K. W Tizard, J P M and Trythall D A H (1957) Gaseous metabolism of the newborn infant *Acta paediat* 46 265
16 Cook, C D Cherry R. B O Brien D Karlberg P and Smith C A (1955) Studies of respiratory physiology in the newborn infant I Observations on normal premature and full-term infants *J clin Invest* 34 975
17 Bonham-Carter R. E (1957) Architectural function of pulmonary capillaries *Lancet* 1 1292
18 Apgar V (1953) Proposal for new method for evaluation of newborn infant *Anesth & Analg* 32 260
19 Apgar V Holaday D A James L S Prince C E and Weisbrot I M (1957) Comparison of regional and general anesthesia in obstetrics *J Amer med Ass* 165 2155
20 Potter E L (1955) State of the lungs at birth *J Amer med Ass* 159 1341
21 Freeman, L C and Scott R. B (1954) Gastric suction in infants delivered by Cesarean section. *Amer J Dis Child* 87 570
22 Apgar V (1956) In Hingson and Hellman s *Anesthesia for Obstetrics* 1st ed. p 310 Philadelphia Lippincott
23 Day R Goodfellow A M Apgar V and Beck G J (1952) Pressure-time relations in the safe correction of atelectasis in animal lungs *Pediatrics* 10 593
24 Donald, I and Lord J (1953) Augmented respiration studies in atelectasis neonatorum *Lancet* 1 9
25 Apgar V Girdany B R. McIntosh R. and Taylor H. C (1955) Neonatal anoxia 1 Study of relation of oxygenation at birth to intellectual development *Pediatrics* 15 653
26 Jost A in discussion following McCance R. A. and Widdowson, E. M. (1954) Water metabolism Cold Spring Harbor Symposium on the Mammalian Fetus 19 164

27 Burnard E. D (1958) Murmur from the ductus arteriosus in the newborn baby *Brit med J* 1 806
28 Benson, F Celander O Haglund, G Nilsson, L Paulsen, L. and Renck, L. (1958) Positive-pressure respirator treatment of severe pulmonary insufficiency in the newborn infant. *Acta anaesth scand* 2 37

CHAPTER VII

EQUIPMENT AND ADMINISTRATION

It is well enough recognized that, in this country the call for anaesthesia in the obstetric department is an emergency measure. It is therefore not unreasonable to insist that a complete range of equipment for providing anaesthesia and resuscitation be kept in a constant state of preparedness in the delivery room It is a duty of the anaesthetic department that this equipment be frequently inspected, tested and, if necessary, replenished. The following observations apply to equipment which, from the point of view of the anaesthetist, must be maintained in each delivery room The obstetrician and the paediatrician will also have an interest in some of the articles discussed, and the joint concern should form part of the basis of co-operation between the three specialities

The *delivery room bed or table* in many hospitals is hopelessly obsolete not only hindering the rapid and efficient working of both obstetrician and anaesthetist, but also providing a potential threat of disaster for the patient. There is a variety of excellent beds now in production but it is not necessary to catalogue the various commercial products in this book The essential features of such a bed are as follows

1 It must be possible easily and rapidly to tilt it through 20 degrees in either direction.

2 By manipulating a simple control it must be possible to cause the lower half of the bed to sink and then to slide beneath the upper part so that the patient may be put into the lithotomy position without having to be dragged and tugged down the table It must still be possible to tilt the table when this manoeuvre has been accomplished

3 Raising and lowering of the whole table must be attainable by the operation of a simple foot-control.

4 All the above-mentioned controls must be at the head-end of the table, and within easy reach of the anaesthetist

5 The leg-supports of the lithotomy poles should be of the moulded type allowing the weight of the patient s legs to be distributed over a considerable area. If stirrups must be used the supporting poles which

are so often seen to be digging into the patient's calves must be well padded.

6 Smooth-running easily secured, well-padded shoulder-rests must be held in readiness

7 It must be possible rapidly to screw a long drip-pole into position on either side of the table and the pole should be kept clipped to the table when not in use

8 It is preferable though not essential that there be an arm-board attachment which can be applied easily to either side of the table

9 The mattress which should be of firm sorbo-like consistency should of course, be in two separate pieces the junction coinciding with the split in the table. It should be of conductive material and should not tend to slip over the polished metal surface of the table

The *anaesthetic machine* will be of the type in use in the general operating theatre and complete with closed-circuit equipment Whether the piping system is used or not gas and oxygen cylinders should be checked daily

The usual range of *face masks airways* and *endotracheal tubes*—cuffed and plain—with their respective *connections* should be kept with the machine in a state of cleanliness and readiness The point made by Parker[1] is well taken namely that in the obstetric department face-masks should be transparent.

Two adult-sized laryngoscopes should be kept on the anaesthetic machine, and their notoriously fickle bulbs tested daily and also prior to induction of every anaesthetic

A special *cupboard* containing the following equipment should be situated within arm's length of the anaesthetist's station

A range of autoclaved and easily identifiable syringes and needles
Several Ghordh-type cannulae.
Regularly autoclaved spinal and epidural packs
Transfusion equipment and cut-down sets (2 adult 1 infant)
Tracheotomy-set (1 adult 1 infant size)
Cardiac massage set.
Routinely tested bronchoscope, preferably light-weight battery type, with appropriate sucker-end.
Large-bore stomach tube (size 10 oesophageal)
Full complement of drugs needed to produce regional analgesia general anaesthesia, hypoaesthesia and relaxation plus the pressor and hypotensive agents apomorphine atropine and the various antagonists
Full complement of intravenous fluids other than blood.

Appropriate bottles for samples of blood to be used for typing and cross-matching together with the necessary laboratory forms

Extra-long tubed stethoscope for taking blood-pressure readings

Blood-pressure should always be recorded before the start of anaesthesia, the *sphygmomanometer cuff* being applied to the arm less likely to be used for transfusion Measurements should be continued and recorded, at intervals throughout the operation

An *electric suction apparatus* tested for efficiency and reliability is essential for each delivery room This must be reserved solely for use by the anaesthetist upon the mother and the appropriate tubing and sucker-end should be laid close to hand for the duration of the operation and the recovery phase Completely spark-proof models are now available and should be preferred

The *gas and air machines* with their accompanying *tubing* and *masks* must be routinely inspected and tested [2]

The *Trilene apparatus* must by order be returned at six-monthly intervals to the National Physical Laboratory for testing The day-to-day care of the apparatus has been well detailed by Seward and Bryce-Smith.[2]

Intelligently formulated and well-kept *record-cards* are an essential part of good obstetric anaesthetic practice Not only do they permit of reliable reflection upon the course of a particular case but analysis of large numbers of such cards will aid greatly the progress of understanding in the speciality Upon such cards should be recorded full details of the analgesia and anaesthesia used relevant aspects of the maternal signs and symptoms and pertinent data regarding the condition of the child before during and after delivery In parentheses it might here be noted that it is an excellent habit for the anaesthetist to insist that the foetal heart sounds be checked immediately prior to his starting work.

The only obstetric anaesthetic record card in use in England—and of which the author is aware—is that devised by Dr R J Hamer Hodges for use in the Portsmouth Hospital Group Details of this are shortly to be published, and it is to be hoped that Dr Hodges example will rapidly be followed.

The *resuscitation table* should carry all the apparatus necessary for the treatment of a depressed infant An admirable example of such a table has been described by Secker [3] The table itself should be freely mobile light in weight able to be tilted from the horizontal through to 15 degrees head-down and of a height which permits the operator to work comfortably whilst sitting on an anaesthetist s stool.

An easily-washable sponge nylon or soft sorbo *mattress* should cover

the surface of the table and Secker[3] makes the excellent suggestion that an oval hole (11 cm by 9 cm) be made in the head-end of the mattress to allow the baby s head to be stabilized, especially during intubation

A 66-gallon *cylinder of oxygen* with a reducing-valve and flowmeter should be attached to the lower end of the table and should be maintained in the customary fashion The tubing leading from the cylinder should be clipped along the side of the table the terminal six inches being allowed to hang freely at the head-end This arrangement helps to reduce the drag on the endotracheal tube

A *suction unit* may be fed from the oxygen cylinder but it is probably more satisfactory to have a small electric sucker held on a shelf at the foot-end of the table The apparatus should be of low displacement and low maximum vacuum

Secker[3] suggests that a *clock* be incorporated into the table Whilst this might be considered as a rather refined luxury there is no doubt that a clock or watch with a prominent second-hand is a necessary article in the delivery room It should be kept well outside of the mother s field of vision for clock-gazing alarms the nervous and depresses the weary

The following equipment should be neatly stored in a drawer of the infant-resuscitation table

Moulded infant-sized *face-masks* made of transparent material

Several Portex No 0 and No 00 *endotracheal tubes* cut to length (see Chapter VI) and with connections attached

Two or three Portex No 000 *airways*

Two or three fine rubber *nasal catheters* with tapered plastic connectors attached

Two or three *rubber catheters* (No 12 French) for oro-pharyngeal and gastric suction with tapered plastic connectors attached The latter should each have a hole—about a quarter-inch diameter—along its length, to facilitate control of suction

Two or three very *fine suction catheters* which may be threaded comfortably through the endotracheal tubes These too should have tapered perforated plastic connectors attached.

Equipment—incorporating *T-piece* or *rebreathing bag*—for maintaining intermittent positive pressure It must be possible to apply the tubing easily but firmly to the endotracheal connection and to the lead from the oxygen cylinder A *manometer* must be included in the system and it is preferable that this be laid alongside the child s head so that manometer and infant thorax may be watched simultaneously

Laryngoscope with 2 infant-sized blades—tested routinely each day and immediately before each delivery

Mucus-catheter—this should have a 'body' (preferably transparent) of such a capacity as to preclude the necessity of having to blow out the contents to leave room for further aspirations A number of similar catheters will of course be kept elsewhere for use at routine deliveries but an advance will have been made when suction machines (offering a negative pressure no greater than 20-40 mm Hg) entirely replace these rather dirty and often traumatic instruments

Receiver—for water used to clear the suction catheters

Two autoclaved 2 ml *syringes* with *needles*

Supply of *levallorphan*

Each piece of equipment intended for use within the infant s mouth or nose should be stored within its individual plastic bag

There is often considerable confusion and sometimes disagreement regarding the desirable location of the infant immediately it is separated from the placenta. There can be no doubt that the infant must be placed on the resuscitation table within arm s length of the anaesthetist even if the latter takes no active part in the treatment of the child. The anaesthetist should be considered as being the director of resuscitation and he should be in a position to observe and if necessary to control any measures taken whether by midwife paediatrician obstetrician or trainee anaesthetist If the anaesthetist is acting as demonstrator and instructor then the necessary arrangements for handing over the care of the mother at the appropriate time will already have been made If there is a serious shortage of attendants and the child is in urgent need of the anaesthetist s attention then a common-sense assessment of the situation must direct the course of action Having the child brought close to the head of the operating table obviously resolves much of the difficulty of the situation under any circumstances The simultaneous appearance of a maternal crisis and neonatal apnoea poses an invidious problem deliberation upon which is outside the scope of this book. However in general terms it might be suggested that, whilst inefficient resuscitative measures if shortly succeeded by adequate treatment might not cause very serious harm to the neonate a similar course of events is likely to produce considerable residual damage in the case of an adult

In many hospitals in this country it is still the practice to perform all Caesarean sections in the general theatre This is to be strongly deprecated, as the two often long journeys add greatly to the perils of both mother and child in many instances There seems little reason why in each unit an

effort should not be made to equip one delivery room for the purpose of conducting Caesarean sections A selection of all the apparatus mentioned in the foregoing pages—including the delivery table—would be entirely applicable to the conduct of such cases

Personnel

As convention has it in this country at the moment anaesthetists appear in the labour ward only to attend operative deliveries and, sometimes breech deliveries and extraction of retained placentae Articles and comments humiliatingly too numerous to detail make it obvious *that even these meagre standards are barely upheld in many hospitals* As stressed elsewhere in this book it is an urgent duty of the senior anaesthetist to ensure that his obstetric colleagues are able to obtain without more than five minutes delay the services of a competent anaesthetist at any time It has previously been pointed out that obstetric anaesthesia is in the main emergency anaesthesia and this fact presents an obvious duty to the anaesthetic department At the same time the obstetrician is rarely caught unawares and in a well-integrated hospital the anaesthetist on duty can usually be given a preliminary warning notice

Within the limits of present-day practice the responsibilities of the anaesthetic department in respect to obstetrics also include

(*a*) Supervision of the training of pupil midwives in all aspects of analgesia for labour

(*b*) The instruction of concerned medical and nursing personnel in the theory and practice of neonatal resuscitation The anaesthetist should be the coordinator but not the inevitable star participant in a team including obstetricians midwives paediatricians and junior anaesthetists the aim of the team being to provide prompt, knowledgeable and efficient relief of neonatal depression

Domiciliary Practice

In this country 35-40 per cent of deliveries are conducted in the home The proportional occurrence of abnormalities is very much lower than is the comparable rate in hospital practice but forceps deliveries are still carried out (amounting to about 6 000 such operations annually) and the family doctor will on occasion be faced with a worryingly depressed infant

Some suggestions regarding domiciliary anaesthesia for delivery and for removal of a retained placenta, have been made in other chapters of this book with some emphasis on the possible scope of hypoaesthesia

The following suggestions are added in the hope that they might prove useful to those general practitioners who have a special interest in obstetrics

Use of the Western Reserve portable anaesthetic machine introduced by Hingson [4] and reported upon in this country by Mushin and Thompson [5] seems to offer considerable advantage over most methods of general anaesthesia previously employed in the home Used in the manner suggested, the machine can be made to deliver a non-explosive mixture of oxygen cyclopropane and helium with which anaesthesia is induced within about 15-30 seconds and may be maintained for 7-10 minutes without replenishing the gases A small soda-lime cannister included in the apparatus prevents a clinically significant increase in carbon dioxide concentration within the system For full details of the construction and use of the machine the reader is referred to the relevant articles [4, 5] It must be remembered that explosion and fire excepted, the hazards of cyclopropane anaesthesia including vomiting and regurgitation are not obviated by this innovation

It seems possible that a modification of the machine could be used for neonatal resuscitation. For this purpose Sparklet cylinders containing pure oxygen (as described by Hingson) would be used and the adult-sized mask replaced by one suitable for an infant It must be very rarely that the initial high pressure referred to in the previous chapter need be applied under conditions of domiciliary practice and the call is probably almost always for assisted respiration The Western Reserve machine is provided with a pressure-limiting safety valve which ensures an upper limit of 20 mm Hg when positive pressure is being applied Used in conjunction with an oral airway the apparatus should be of considerable service in aiding a mildly or moderately depressed infant As a means of coordinating ideas and experience between domiciliary and hospital practices it is suggested that the apparatus should also find a place in the delivery room scheme of neonatal resuscitation

A much more simple and probably as effective piece of equipment for use in resuscitation is that based upon a suggestion by Safar [6] This consists merely of two oro-pharyngeal airways—preferably Portex—one infant size the other adult size which are taped together at their flanged ends so that there is continuity between the interiors of the two To reduce the spread of droplet infection a few layers of gauze may be placed between the airways Both tape and gauze should of course be replaced after each case, the airways sterilized, and the whole stored in a plastic bag Short sharp puffs through this device appropriately placed, should provide a more comfortable and possibly a more efficient

way of inflating the infant's lungs than that offered by the mouth to-mouth method of Biblical fame

REFERENCES

1 Parker R B (1954) Risk from the aspiration of vomit during general anaesthesia *Brit med J* 2 65
2 Seward E H and Bryce Smith R (1957) *Inhalational Analgesia in Childbirth* 1st ed Oxford Blackwell
3 Secher O (1956) Resuscitation table for the newborn *Lancet* 2 341
4 Hingson R A (1958) The Western Reserve anesthesia machine oxygen inhalator and resuscitator *J Amer med Ass* 167 1077
5 Mushin W W and Thompson P W (1958) Cyclopropane in non-explosive mixture for out patient anaesthesia *Brit med J* 1 1376
6 Safar P and McMahon M (1958) Mouth to-airway emergency artificial respiration *J Amer med Ass* 166 1459

EPILOGUE

Enough emphasis has already been laid in this book on the necessity of providing adequate anaesthetic cover for operative obstetrics in hospitals Attention has also been directed towards the need to encourage vigorous and co-ordinated investigations into the immediate and long-term effects of obstetric analgesia and anaesthesia upon the child together with complementary studies of normal perinatal physiology All these are matters of urgent concern to the welfare of our patients and to the self-respect of our speciality but what of the day after tomorrow? There appear to be two challenges which must be faced within the next few years the delay being enforced by lack of manpower in the one case and by lack of knowledge in the other

At the present time, of the 260 000 domiciliary deliveries occurring annually in England and Wales, about 6 000 are operative and require the aid of anaesthesia Comparable figures must apply to the whole of the United Kingdom Not much appears to be known about the infant mortality and morbidity rates in domiciliary obstetrics but there is some suggestion that maternal mortality—and probably maternal morbidity—is lower than in hospital practice[1] This has been referred to already in previous chapters and it has been proposed that the discrepancy is in part due to the greater incidence of severe obstetric complications in hospital practice and in part to the extended experience of many general practitioners in their chosen methods of anaesthesia—an experience which in many cases is based upon that gained during medical training in the days before anaesthesia assumed its present highly specialized role Whilst it is doubtful that the figure of 6 000 operative deliveries per year will be much reduced during the coming ten to fifteen years it is certain that there will in that period be many replacements in the ranks of general practitioners undertaking domiciliary obstetrics It has already been suggested, in the Introduction that prospective general practitioners should have received appropriate training before becoming eligible to practice obstetric anaesthesia under home conditions for though an outlet forceps operation might almost always be a simple essay in obstetrics it can never be regarded as being child's play for the anaesthetist

It is doubtful if a general practitioner anaesthetist service will ever

achieve comprehensive coverage for all domiciliary obstetrics and it should be the aim of the local hospitals to provide one or two anaesthetists who will take part in a district duty rota—this of course being distinct from the obstetric flying squad service It is easy to envisage a training programme involving both junior anaesthetists and interested general practitioners which would coincidentally lead to a more enlightened approach by specialist anaesthetists to the problems of domiciliary anaesthesia

The second long-term issue is probably of even greater importance Related to the whole of medicine in more general terms it has been well presented by Dr Cicely Williams[2] British hospitals undertake the responsibilities of conducting undergraduate and post-graduate training for very many visitors from overseas who intend to practice in their respective homelands Increasing numbers of men and women are receiving their tuition from these British-trained doctors without themselves travelling to this country and thus the circle widens We must soon *seriously begin to question the applicability to newly-developing* countries of the methods of obstetric anaesthesia which we teach for home consumption Even in some highly industrialized states the challenge is immense A recent paper[3] remarked upon the fact that in Japan before World War II neither analgesia nor anaesthesia was given for labour unless specifically indicated Now it seems the demand for relief from pain is growing steadily and in the face of a gross shortage of anaesthetists (and an absence even of U S -style nurse anaesthetists) there must be considerable difficulty in deciding upon a safe way of providing a satisfactory response to the demand In the underdeveloped countries especially those in which small communities are widely scattered and the doctor is likely to work in comparative isolation the problem is even greater[4] Many possibly most of the methods which we currently teach are obviously completely unrelated to the realities of overseas practice To retain our role as a university of the world we must accept in some measure a reversal of the teacher-student relationship and eagerly *learn* of the precise conditions under which many of our visitors will eventually work Only on such a basis will we be able to apply our special knowledge of the relevant physiology and pharmacology to the solving of many of these problems At the moment Hingson is engaged in an initial sortie into this field At the time of writing no report of his recently concluded Afro-Asian tour has been published no doubt he will be able to indicate many modifications which we must introduce into our curricula for students from overseas but there will certainly be a need for others not yet appreciated and his is only one of several methods of investigation

The British Commonwealth embraces almost one-third of the world's population and most of its communities are included in the category under discussion. We in the United Kingdom have long had the privilege of culling sifting distilling and transmitting knowledge of the health and treatment of these variegated populations In matters of basic standards of health, sanitation response to drugs emotional reactivity cultural standards domestic relationships and the like, the norm of each society differs widely from that of our own and those of others in the Commonwealth. If we are to fulfil one of our major obligations accepted by our identification with the Faculty of Anaesthetists of the Royal College of Surgeons then we must soon relate a part of the teaching of obstetric anaesthesia—as indeed, of all anaesthesia—to the specific problems of these more exotic environments

REFERENCES

1 Parker R. B (1956) Maternal death from aspiration asphyxia *Brit med J* 2 16
2 Williams, C D (1958) Social medicine in developing countries. *Lancet* 1 863
3 Yabuki, G and Hong S (1957) 'Pontocaine saddle-block anesthesia in obstetrics for the general practitioners in Japan. *Far East J Anesth* 1 20
4 Malkoni, R P and Sikand S (1956) Forceps delivery under pudendal nerve block anaesthesia *J Obstet Gynaec India* 17 193

INDEX